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Surface-Tolerant Coatings for Aircraft Hangars, Flight Control Tower, and Deluge Tanks at Fort Campbell

Final Report on Project AR-F-320 for FY05

L.D. Stephenson, Ashok Kumar, Timothy D. Race, and Steve Williams

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L.D. Stephenson and Ashok Kumar

Construction Engineering Research Laboratory
U.S. Army Engineer Research and Development Center
2902 Newmark Drive
Champaign, IL 61822

Timothy D. Race

Corrosion Control Consultants & Labs, Inc.
135 North Addison Avenue, Suite 108
Elmhurst IL 60126

Steve Williams

Manta Industrial, Inc.
5233 Hohman Ave.
Hammond, IN 46320

Final report

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Abstract: The objective of this research was to demonstrate and implement cost-effective paint maintenance procedures for steel structures, including overcoating existing coatings with surface tolerant, self-healing, and extremely durable coatings. Maintenance painting of this type does not require extensive surface preparation, and can be significantly less expensive than other maintenance practices, particularly when the existing coating contains lead or other hazardous materials. Candidate steel and galvanized steel structures requiring maintenance painting at Fort Campbell were assessed to determine the suitability of various paint maintenance procedures, prior to overcoating. Air dry fluoropolymer coatings, implemented for the flight control tower, have emerged as a premium recoat product for factory installed polyvinylidene fluoride coatings as well as for use in coating other weathered coatings. Moisture cured polyurethanes (MCU), which are tolerant of relatively poor application conditions and generally can be applied at very high humidity and low temperatures, were successfully implemented as overcoatings for deluge tanks and aircraft hangars. Self-healing smart coatings, which incorporate microcapsules mixed into paint as a dry powder at the time of application, were also implemented for critical areas of deluge tanks.

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Introduction

The U.S. Army Engineer Research and Development Center (ERDC) contracted with S & K Technologies, St. Ignatius, MT (subcontractor Manta Industrial, Hammond, IN) under FY05 OSD Project No. AR-F-320 to conduct field demonstration and implementation of cost-effective paint maintenance procedures for the protection of galvanized steel buildings and steel deluge tanks at Fort Campbell. The maintenance procedures include surface preparation, environmental protection, and paint application.

The painting contractor was Manta Industrial. The Project Manager for Manta Industrial was Steve Williams; Mark 10 Associates (Michael O'Brien, President), performed quality assurance testing for the government and assisted in the return on investment evaluation.

The Project Manager was Dr. Ashok Kumar. The Associate Project Manager was Dr. L. D. Stephenson. The stakeholders are Audie Hardin (Chief of Design Branch DPW, Fort Campbell Directorate of Public Works), Steve Jackson (Installation Management Agency –South East Region Office), Paul Volkman (Headquarters-Installation Management Command), David Purcell, (Headquarters-Assistant Chief of Staff for Installation Management), and Hilton Mills (Army Materiel Command), as well as Tri-Services Working Integration Process Team representatives, Nancy Coleal (Air Force Civil Engineering Service Agency), and Tom Tehada (Naval Facilities Engineering Systems Command).

At the time this report was published, the Chief of the ERDC-CERL Materials and Structures Branch was Vicki L. Van Blaricum (CEERD-CF-M), the Chief of the Facilities Division was L. Michael Golish (CEERD-CF), and the Technical Director for Installations was Martin J. Savoie (CEERD-CV-ZT). The Deputy Director of ERDC-CERL was Dr. Kirankumar V. Topudurti, and the Director was Dr. Ilker Adiguzel.

COL Gary E. Johnston was the Commander and Executive Director of ERDC, and Dr. James R. Houston was the Director.

Executive Summary

The objective of this research was to demonstrate and implement cost-effective paint maintenance procedures including overcoating existing coatings with surface tolerant, self-healing, and extremely durable coatings. Overcoating is defined as the practice of painting over existing coatings to extend the service life. Maintenance painting of this type does not require extensive surface preparation. Overcoating can be significantly less expensive than other maintenance practices particularly when the existing coating contains lead or other hazardous materials.

Air dry fluoropolymer coatings have emerged as a premium recoat product for factory installed polyvinylidene fluoride coatings as well as for use in coating other weathered coatings. Moisture cured polyurethanes (MCU) are a successful group of overcoat materials. MCU are tolerant of relatively poor application conditions and generally can be applied at very high humidity and low temperatures. Candidate steel and galvanized steel structures requiring maintenance painting were identified at Fort Campbell. The structures were assessed using established techniques to determine the suitability of various paint maintenance procedures. Self-healing smart coatings incorporate microcapsules, which are mixed into paint as a dry powder at the time of application. Microcapsules may instill the coating with special properties, including self-healing, corrosion resistance, and passive sensing.

Overcoating was implemented and a cost report and analysis were conducted. The technology implemented at Fort Campbell validates the use of surface tolerant overcoatings and self-healing coatings. Unified Facilities Guide Specification (UFGS) identified to be updated with the new information presented in this report are UFGS 09900 “Paints and Coatings” and UFGS 09920S “Painting and Coating.”

The surface tolerant overcoating technology implemented is recommended as corrosion protection for steel structures that meet the overcoating criteria. The technology is applicable for multiple regions and installations, especially those in hot and humid environments locations where atmospheric corrosion is of concern.

Unit Conversion Factors

Multiply	By	To Obtain
gallons (U.S. liquid)	3.785412 E-03	cubic meters
inches	0.0254	meters
microns	1.0 E-06	meters
mils	0.0254	millimeters
pounds (force) per square inch	6.894757	kilopascals
square feet	0.09290304	square meters

1 Background

Overcoating may be defined as the practice of painting over existing coatings as a means of extending the life of the old coating. Maintenance painting of this type does not require extensive surface preparation. Overcoating can be significantly less expensive than other maintenance practices, particularly when the existing coating contains lead or other hazardous materials.

The practice of overcoating experienced a growing level of acceptance over the decade of the 1990s. Numerous local and state transportation authorities are using overcoating as a maintenance painting strategy for bridges. The oil refining industry overcoats lead-painted fuel storage tanks, and municipalities overcoat elevated and ground water storage tanks. In general, however, the practice is still consider experimental and continues to evolve as new materials and surface preparation methods are applied.

Other maintenance painting practices exist. The most common is total removal and coating replacement, also known as repainting. Total coating removal is generally performed by abrasive blasting. However, containment and disposal of abrasive blasting surface preparation debris, worker protection, and other regulatory compliance costs combine to make removal of hazardous paints very expensive. The added costs for worker health, environmental monitoring, waste disposal, and containment are significant.

Overcoating is performed with a significant degree of risk that the overcoated system may fail catastrophically by delamination. In some cases, overcoating has been used improperly by the industry. Because of the substantial initial cost savings that overcoating has compared to repainting, the inducement to overcoat is strong. The cost difference between overcoating and repainting cause owners to be less averse to the risks involved in overcoating. Owners must assess the risk of overcoating. If these risks are found to be acceptable, then the facility owner should proceed in a manner that reduces the risks inherent in overcoating.

2 Lessons Learned

The surface tolerant technology recommended under this project is advocated as corrosion protection for steel structures that meet the overcoating criteria as discussed in this report. The technology is applicable for multiple regions and installations, especially those in hot and humid environments where atmospheric corrosion is a concern. Overcoating with surface tolerant coatings, such as those described, can also be a useful solution to problems with lead hazard control due to lead based paints.

It is recommended that existing Unified Facilities Guide Specifications (UFGS), Engineering Instructions, Technical Instructions, and Technical Manuals (TM) be revised to include the specifications and instructions for installing these surface tolerant coatings. Specific UFGS that need to be updated with the new information presented in this report are UFGS 09900 “Paints and Coatings” and UFGS 09920S “Painting and Coating.”

3 Technical Investigation

Problem

An inspection of steel structures at Fort Campbell indicated problems with atmospheric corrosion. Protective coatings used on steel and galvanized steel are susceptible to peeling and other deterioration caused by the combined effects of sunlight, moisture, and temperature cycles.

In the past, hexavalent chromium and lead-containing paints were used as a matter of routine. Today it is well understood that these types of coatings are hazardous to workers and the environment. Containment and disposal of surface preparation debris, worker protection, and other regulatory compliance costs combine to make removal of hazardous paints very expensive. According to a Federal Highway Administration (FHWA) report (Kogler et al. 1997), bridge maintenance painting costs have nearly doubled over the past 5 years. Typical bridge maintenance painting contracts involving complete coating removal and repainting average $5.05/ft^2 for nonhazardous coatings and $10.60/ft^2 for hazardous paint removal. The added costs for worker health, environmental monitoring, waste disposal, and containment for hazardous paint removal are significant.

Overcoating can be significantly less expensive than other maintenance practices, particularly when the existing coating contains lead or other hazardous materials. The FHWA study concluded that, for mild service environments, overcoating is more cost-effective than other maintenance options on a life cycle cost basis. They reported an average equivalent annual cost of $1.04/ft^2 for overcoating using a 3-coat alkyd system versus $1.99/ft^2 for total removal and repainting with an inorganic zinc/epoxy/polyurethane system.

Objective

The objective of this research was to implement cost-effective paint maintenance procedures for the protection of galvanized steel buildings and steel deluge tanks at Fort Campbell. The maintenance procedures include surface preparation, environmental protection, and paint application.

Approach

Candidate steel and galvanized steel structures requiring maintenance painting were identified. The structures were assessed using established techniques to determine the suitability of various paint maintenance procedures, particularly overcoating, as discussed below. Overcoat materials, surface preparation methods, and environmental controls were specified. Overcoating was implemented, an analysis was conducted, and a cost report produced with a projected return on investment (ROI) calculation, as given in Appendix A.

Risk associated with overcoating

The practice of overcoating involves a significant degree of risk that failure will occur. The risk of premature coating failure of abrasive blasted and coated structures is relatively small compared to overcoated structures. Because of the increased risk of failure, a careful assessment of the service environment and the condition of the aged coating are needed to avoid costly overcoating failures.

The primary risk associated with overcoating is that the coating system will fail in adhesion causing the aged coating and newly applied overcoat to delaminate. When a delamination failure occurs, the money invested in overcoating is lost and repainting is required. Delamination of a lead-containing coating may also represent an environmental hazard. The remedial cost of an unintentional introduction of lead into the environment may be significant.

Delamination failures are difficult to predict. However, an understanding of the fundamental principles involved will reduce the probability of a delamination failure. Delamination failure is mainly caused by internal stress in the overcoat material that cannot be supported by the underlying aged coating. Internal stress occurs as the applied overcoat contracts, either from solvent evaporation or curing. Several items affect the degree of internal stress in the overcoat material including: generic type of coating; formulation; and film forming conditions. The stress present in the overcoat is important because it is transmitted to the base coating.

As coatings age, film stress generally increases. Aging may result in additional cross-linking and film shrinkage. An example of age-related stress increase is the oxidative curing of alkyds. Temperature cycles and ex-

tremes may also affect the degree of internal stress, with higher temperatures leading to lower stress and colder temperatures causing higher stress. The increased stress associated with cold temperatures is a major cause of overcoat system failure by delamination. Plasticizer migration may lead to reduced elasticity or embrittlement of both aged coatings and overcoats. Brittle coatings are more apt to crack during temperature cycles. The application of the overcoat may also affect the internal stress of the aged coating. Solvent migration may initially reduce the stress in the existing coating; however, subsequent solvent evaporation will result in an increase in the film stress. Resin in the overcoat material may penetrate the aged paint, forming a stress zone within the old coating.

The internal stress of the overcoat is countered by its adhesion to the aged coating. A loss of adhesion of the aged coating may result in cracking of the overcoat because internal stress is no longer supported by the underlying coating. This is true when the internal stress of the overcoat exceeds its tear strength. When the tensile stress in the overcoat exceeds that in the aged coating and the overcoat cracks, then peeling and delamination are likely to occur. It is good practice to have higher tensile strength and rigidity in the underlying aged coating than in the overcoat. New coating systems are specifically designed this way. Overcoat systems should be designed this way as well. However, in practice it is difficult to assure that the stress of the overcoat will not overwhelm the adhesion of the aged coating.

Thick layers of aged coatings tend to have higher levels of stress. Large peeling forces may occur during drying, curing, and aging of the overcoat. Overcoated thick films, which are inherently more highly stressed, have a greater chance of failing by delamination than do overcoated thin films with less internal stress. Thick, highly stressed coatings are more likely to suffer damage from impingement with a subsequent loss of adhesion that may affect the life of the overcoat system.

The mechanical properties of coatings may change as they age. Age-related changes are due primarily to phenomena within the coating that increase its glass transition temperature. As the aged coating's glass transition temperature increases, its internal stress increases, adhesion decreases, and brittleness increases. The glass transition temperature increase is generally the result of thermal and photo radiation effects. For acrylic latex coatings, it has been shown that the increase is due entirely to photo radia-

tion. For oil paint, the effect is mainly due to photo radiation, and for alkyd, it is due to both thermal and photo radiation, with thermal effects playing a greater role. Long oil coatings generally take longer to embrittle than short oil coatings.

Epoxy and alkyd coatings will chalk and erode when exposed to sunlight for long periods. This erosion does not affect overcoating provided loose chalk is removed before painting. Eroded topcoats with exposed primer can still be good candidates for overcoating, assuming the aged coating has acceptable adhesion and surface rusting is not too extensive.

The adhesion of the aged coating to the substrates is one of the most important factors affecting the overcoating process. Poorly adherent coatings are more likely to delaminate when overcoated than are aged coatings with good adhesion. Poor intercoat adhesion in aged multi-coat systems may also result in overcoat delamination failures. Coating type, thickness, age, and the presence of mill scale will affect the adhesion of the existing coating.

The condition of the substrate may also affect the performance of the overcoat system. In general, the more corrosion that is present, the more surface preparation that will be needed. Mechanical cleaning, especially abrasive blasting, may disrupt the adhesion of the aged coating adjacent to the removal areas. Additionally, overcoating may not be cost-effective if extensive surface preparation is required. The original surface preparation may also play a role in the performance of the overcoat to the extent that it affects coating adhesion over mill scale and other poorly cleaned surfaces. This loss of adhesion may cause localized problems on structures that were not cleaned uniformly prior to receiving the original coating.

Problems associated with surface contaminants are not specific to overcoating; however, contaminants are less likely to be removed in preparation for overcoating because less surface preparation is typically conducted. Minimal surface preparation is performed to reduce costs and to lower environmental and worker exposures to lead-containing dust. Rigorous surface preparation is also likely to cause mechanical damage to the aged coating that could lead to delamination failure.

Thermal and photo radiation-induced increases to the glass transition temperature may lead to embrittlement and reduced adhesion of the aged

coating. Oil and oil-modified alkyds on structural components exposed to thermal and photo radiation will be more prone to these age-related effects. Similar coatings in protected areas that are not directly exposed to the sun may be more suitable for overcoating. Thermal cycling is another weather-related effect. Internal coating stress may increase to unsupportable levels at low temperatures, explaining why many overcoat delamination failures occur during or after cold spells. Structures in mild climates are less likely to be exposed to low temperatures that may precipitate delamination failures. Conversely, oil and alkyd coatings exposed in sunny climes may age faster than in other locales.

Severe exposure environments, such as immersion, and chemical and marine atmospheres, are usually not suitable for overcoating. FHWA research has shown that, for severe service environments, total removal and replacement of the aged coating with a high-performance coating system is more cost-effective than overcoating.

Practices for assessing risk in overcoating

Techniques for assessing risk in overcoating include visual and physical inspections and application of a test patch, followed by a post-inspection after a specified time period. Visual inspection is the quickest and least expensive means of assessing a structure to determine the applicability of overcoating. Inspection supplies a nominal amount of information including a general assessment of the extent, nature, and location of corrosion. A physical inspection requires direct access to the coated surfaces. It supplies useful information about film thickness and adhesion. A patch test supplies the most definitive information of any assessment technique. At its completion, the engineer should know to a high degree of certainty whether the selected combination of surface preparation and overcoat material will perform well.

Assessing the exposure environment

The first step in determining the feasibility of overcoating is to classify the service environment. The Society for Protective Coatings (SSPC) defines and classifies types of exposure environments or environmental zones. It is important to identify the type of environmental zone because overcoating should only be considered for certain types of exposures.

SSPC defines four types of wet exposures. Environmental zones 2A and 2B are frequently wet by fresh and saltwater, respectively. These exposures involve condensation, splash, spray, or frequent immersion. Condensation in this case is either continuous or nearly continuous. Saltwater environments may include bridges, docks, piers, and platforms over salt water. Coastal structures within 250 meters of the shoreline may also meet the definition, especially when prevailing winds are from offshore. Environmental zones 2C and 2D are fresh and saltwater immersion, respectively. Overcoating should not generally be considered for wet exposures.

Overcoating should not be performed on structures or components exposed in SSPC environmental zones 3A (chemical, acidic), 3B (chemical, neutral), 3C (chemical, alkaline), 3D (chemical, solvent), or 3E (chemical, severe). Industrial atmospheres may or may not meet the definition of zone 3A (pH 2.0 - 5.0). Structures in mild industrial atmospheres may be considered for overcoating. Mild industrial atmospheres are typical of most industrialized cities in the United States. However, certain industrialized areas in the United States and in developing industrial nations are quite severe, and structures in these areas should not be overcoated.

Environmental zones 1A (interior, normally dry) and 1B (exterior, normally dry) are considered acceptable for overcoating. Most structures or components generally fall into one of these categories. Zone 1B is typified by normal rainfall and atmospheric temperatures. Bridge structures on which de-icing salts are used are generally considered to be exposed in zone 1B. In practice, however, portions of these bridges should be classified as zone 2B. Surfaces in zone 2B can be successfully overcoated, but in general it is more cost-effective to perform total removal and repainting with a high performance coating system. The practice of using two or more maintenance painting practices on a single structure is known as zone painting, wherein each exposure zone on the structure is treated separately.

Visual assessment techniques

A quantitative visual inspection of an aged coating system should be conducted to determine the extent and degree of rusting. Rusting should be rated on a scale of 0 to 10 as described in American Society for Testing and Materials (ASTM) D 610 Standard Test Method for Evaluating Degree of Rusting on Painted Steel Surfaces. ASTM D 610 is supplemented by a series of color photographs depicting various levels of rust. Representative

components and/or areas of the structure should be individually evaluated.

1. The first step in performing the visual assessment is to conduct a general survey of the structure to identify representative components of the structure. For water tanks, representative components might include the outer shell, roof, ladders, and piping. The service environment of each component should be identified.
2. The second step is to identify areas with typical levels of coating degradation and rusting for each type of component.
3. The third step is to identify areas with a much greater level of degradation than the typical areas. The types of components or structural characteristics that correspond with these areas should be noted.
4. The final step is to evaluate the degree of rusting on typical areas and worse than normal areas.

Physical assessment techniques

A physical inspection of the structure and aged coating system should be conducted to determine the paint film thickness, adhesion, and presence of mill scale. The quickest method of measuring paint adhesion is ASTM D 3359 Standard Test Methods for Measuring Adhesion by Tape Test. ASTM D 3359 employs a sharp blade, which is used to scribe through the coating to the substrate. Method A employs an X-shaped scribe and is used for paint films thicker than 5.0 mils. Method B calls for a series of cuts in a crosshatch pattern and is used for relatively thin film coatings. The specified tape is applied to and removed from the scribed area and the adhesion is rated based on the amount of paint removed from the substrate. In practice, Method A is almost always used when assessing coating adhesion in the field. The adhesion should be measured at a minimum of five random locations on each type of representative component identified during the visual assessment. For large components or structures, a minimum of five measurements per 10,000 ft^2 should be performed.

The thickness of the aged paint system should be determined in accordance with SSPC PA-2 Measurement of Dry Paint Thickness with Magnetic Gages. Dry film thicknesses should be measured for each representative component of the structure. Film thickness may be categorized as thin (0 < 10 mils), medium (10 - 20 mils), or thick (> 20 mils).

The presence of mill scale is tested by removing a small area of coating. The aged coating can be removed using chemical stripper or by abrading the coating. A saturated copper sulfate solution is then applied to the steel surface. If the substrate is mild steel, copper will plate out on the surface forming a copper-color deposit. Surfaces covered with mill scale will turn black or not exhibit a change of appearance. The mill scale determination should be made on each type of representative component identified during the visual assessment. For large components or structures, a minimum of three tests per 10,000 ft^2 should be performed.

Acceptance criteria for overcoating

Acceptance criteria are presented for percent rusted area, adhesion, and film thickness. Maximum rusting of 10% (rust rating of 4) for typically degraded areas and 17% (rust rating of 3) for the most severely degraded portions of the structure are recommended. The work necessary to clean and paint structures corroded to this degree approaches that required for complete removal and replacement. The performance of the applied overcoat system on the severely degraded substrate is also unlikely to be as good as that of a new paint system applied over blast-cleaned steel.

Table 1 contains criteria for assessing the risk of overcoating based on film thickness and adhesion of the existing coating. The criteria are based on the principle that the risk of failure increases with increasing film thickness and decreasing adhesion. Risk is categorized as NONE (essentially no risk), LOW, MODERATE, HIGH, and CERTAIN (failure likely). Risk refers to the probability that the coating will fail catastrophically by delamination. The maximum level of risk that should be accepted on most Corps of Engineers projects using these criteria is LOW.

Table 1. Risk-based acceptance criteria; coating thickness and adhesion.

Adhesion (D3359)	Thin (<10 mils)	Medium (10-20 mils)	Thick (>20 mils)
5A or 5B	NONE	NONE	NONE
4A or 4B	NONE	NONE	NONE
3A or 3B	NONE	NONE	LOW
2A or 2B	LOW	LOW	MODERATE
1A or 1B	MODERATE	HIGH	HIGH
0A or 0B	CERTAIN	CERTAIN	CERTAIN

Table 2 contains criteria for assessing the risk of overcoating based on film thickness and adhesion of the existing coating on substrates covered with

mill scale. The criteria are based on the principle that the risk of failure increases when mill scale is present. Risk is categorized as NONE (essentially no risk), LOW, MODERATE, HIGH, and CERTAIN (failure likely). Again, the maximum level of risk that should be accepted on most Corps of Engineers projects using these criteria is LOW.

Table 2. Risk-based acceptance criteria for mill scale bearing surfaces.

Adhesion (D3359)	Thin (<10 mils)	Medium (10-20 mils)	Thick (>20 mils)
5A or 5B	LOW	LOW	LOW
4A or 4B	LOW	LOW	LOW
3A or 3B	LOW	LOW	MODERATE
2A or 2B	MODERATE	MODERATE	HIGH
1A or 1B	HIGH	CERTAIN	CERTAIN
0A or 0B	CERTAIN	CERTAIN	CERTAIN

Overcoating practices

The process of overcoating generally includes the following:

- low-pressure water washing or hand washing to remove surface contaminants;
- abrasive blasting or power or hand tool cleaning to remove corrosion products and loose paint;
- dust removal; and
- application of overcoat materials.

Recommended practices are discussed below and summarized in Table 3.

Contaminant removal

Surface contaminants must be removed prior to overcoating the aged coating. Contaminants such as soluble salts, loose chalk, dirt, grease, oil, and mildew may interfere with the adhesion of the overcoat material to the aged coating. Contaminants may be removed by power washing or hand washing.

Industry practices include power washing with water at pressures as low as 600 psi to as high as 7500 psi. Pressures between 5000 and 7500 psi are capable of removing significant amounts of loose coating and well as minor quantities of relatively adherent coating. Such pressures are higher than required to remove surface contaminants and as such are more ap-

propriately described as a surface preparation method than as cleaning. In any case, cleaning at higher pressures will almost certainly require the collection and testing of the waste water for lead contamination. Intermediate pressures are generally more accepted as appropriate for removal of surface contaminants. In practice, water pressure is generally specified as a range because of variability in operator technique and degree of adherence and the nature of surface contaminants. A biodegradable detergent is often added to the cleaning water. Cleaning water is usually applied at lower pressures in the 400 to 600 psi range. Rinse water pressures are generally higher, usually in the 1500 to 4000 psi range.

Waste water from pressure washing should be tested. Water that exhibits the hazardous characteristic must be disposed of as a hazardous waste. Filtering the solids from collected water may be sufficient to reduce the hazardous characteristic. Some facility owners do not specify that the wash water must be collected. Collection of wash water from elevated structures may be difficult. Generally nets or screens are used to collect dislodged particulate and the water is allowed to spill onto the ground or be discharged into the waste water system. Enforcement and interpretation of regulations governing such operations are highly variable. Waste water from power washing averages 100 to 200 gallons per 1000 ft^2 of surface cleaned. Production rates for power washing average about 1000 ft^2/hour.

Removal of surface contaminants may also be performed by hand washing the surface. Washing is generally performed using mild detergents. Bleach may be added to help eliminate mildew. The cleaning solution is applied and the surface is scrubbed with an abrasive pad such as 3M Scotch-Brite or other nonwoven abrasive fabric. Clean water is applied with rags or sponges to rinse the surface. The method is quite effective at removing tenacious contaminants such as chalk and mildew. Ground tarps are sufficient for collecting the minimal quantities of debris and waste water produced. Waste water from hand washing averages 10 to 20 gallons per 1000 ft^2 of surface cleaned. Production rates for hand washing average about 150 ft^2/hour.

Both power washing and hand washing techniques are recommended for contaminant removal on Corps of Engineers projects. The technique to be utilized should be selected by the specifier.

Surface preparation

Surface preparation methods should be selected to minimize damage to the aged coating while providing a clean surface, free of loose corrosion and loose paint. Sweep and brush-off blasting may disrupt the adhesion or fracture the aged coating and may lead to subsequent failures of the overcoat system. Similarly, spot or zone cleaning using an abrasive method may result in blast media impingement damage to adjacent coated areas. This may also lead to adhesive failures of the overcoat system. Abrasive blasting is not recommended for the preparation of surfaces for overcoating.

Power washing followed by power tool cleaning is used by several state departments of transportation for preparing surfaces for overcoating. Power washing removes surface contaminants including dirt, chalk, and salt. Power tools are then used to spot clean corroded areas and to remove loose coating. Depending on the nature of the structure, several types of power tools may be required to prepare the surface. Typical power tools used include needle guns, abrasive wheel or disc sanders, and rotary impact tools. Rotary impact tools or needle guns are needed to remove thick deposits of rust scale. Rotary tools (e.g., wheel and disc sanders) equipped with nonwoven abrasive pads (e.g., 3M Clean-n-Strip) are well suited for cleaning broad flat areas.

Two levels of cleanliness may be specified using power tools: SSPC-SP 3 Power Tool Cleaning and SSPC-SP 11 Power Tool Cleaning to Bare Metal. SSPC-SP 11 is significantly more expensive than SSPC-SP 3 and produces a higher degree of cleanliness than is necessary for overcoating. SSPC defines the degree of cleanliness in SP 3 as the removal of all loose mill scale, loose rust, loose paint, and loose detrimental matter. Furthermore, it is not intended that adherent mill scale, rust, and paint be removed by this method. The SP 3 written standard is supplemented by a visual standard, SSPC-VIS 3, Visual Standard for Power- and Hand-Tool Cleaned Steel. Surfaces suitable for overcoating are most accurately depicted by Condition E of VIS 3. Condition E depicts mostly intact paint applied over blast-cleaned steel. Condition G is applicable to a lesser degree and shows a thoroughly weathered, blistered, and stained paint applied over a mill scale bearing steel. SSPC-SP 3 implies that the entire surface is cleaned with the power tools. From a practical standpoint, however, it is more cost-effective to minimize the surface area that is cleaned with power tools. Surfaces resembling Condition E of VIS 3 will be adequately prepared if only areas

with visible spots of corrosion or loose paint are power tool cleaned. Surfaces resembling Condition G should be power tool cleaned in their entirety. Some specifiers have gone to the extent of specifying a minimum size corrosion spot that requires power tool cleaning. This practice may also be cost-effective as it avoids the need to clean areas with pinpoint or small spots of corrosion that may be readily overcoated without cleaning. Another important aspect of power tool cleaning is the need to remove loose paint back to sound paint and to feather edges. This practice will help prevent lifting of the aged coating and will provide a better appearance.

SSPC-SP 2 Hand Tool Cleaning provides the same definition for degree of cleanliness as SP 3 Power Tool Cleaning. However, based on research performed by the New England regional coalition of state departments of transportation (NEPCOAT), the performance of overcoat materials applied over SP 2 cleaned surfaces is significantly poorer than the same materials applied over SP 3 cleaned surfaces. Hand tool cleaning is not recommended for preparing surfaces for overcoating.

Dust removal

Residual dust produced during power tool cleaning must be removed from the surface prior to overcoating. Common dust removal methods recommend in SSPC-SP 3 include brushing, blow off, and vacuuming. Brushing and blow off methods should be avoided because they may introduce lead-containing dust into the air. Wiping down surfaces with rags wet with water or solvent is the recommended practice. Rags wet with water reduce worker exposures to airborne dust. Solvent wiping also reduces airborne dust exposure and may also dry faster and remove more contaminants than water wiping. Solvent wiping with clean white rags wet with a high flash solvent is the preferred method.

Overcoat application techniques

Corroded areas and areas of loose paint that have been prepared by power tool cleaning should receive a coat of the specified primer. Areas of eroded topcoat where the original primer is exposed or shadows are visible should also be primed. In cases where corrosion spots and power tool cleaned areas are uniformly dispersed and numerous, it may be more cost-effective to apply the primer to the entire surface. Spot priming numerous individual rust spots by brush may be more time consuming than priming the entire surface using a roller. The primer and/or the first full coat of the over-

coat system should be applied by brush or roller. Subsequent coats may be applied by spray, brush, or roller.

Table 3. Summary of recommended overcoating practices.

Procedure	Description
Contaminant Removal	(a) Power Wash – mild detergent solution at 400-600 psi; rinse at 1500-4000 psi (b) Hand Wash – mild detergent and bleach solution with abrasive pad; rinse with clean water
Surface Preparation	SP 3 Power Tool Clean – to remove loose corrosion and coating; feather edges
Dust Removal	Hand wipe surfaces with clean rags wet with water or high flash solvent
Overcoat Application	Brush and roll to spot prime; brush, roll, or spray topcoats

Overcoat materials

Overcoat materials should have good penetration and wetting characteristics. They should be relatively low build materials with good flexibility and should not contain strong solvents. Some commercially available coatings have been specifically formulated for overcoating. Certain products have been validated in use as overcoats and should be considered as candidates. Types of products marketed by paint manufacturers for overcoating include acrylic latex, calcium sulfonate, alkyd, epoxy, oil and oil-modified alkyd, fluoropolymer, polyurethane, polyester, wax, petrolatum tape, urethane-latex, and epoxy-urethane coatings.

Based on research performed by NEPCOAT, solvent-borne overcoat materials are generally superior to water-borne products. However, coating materials containing strong solvents or those with a high degree of internal stress should not be used for overcoating. Strong solvents may have a tendency to lift the old coating or to cause resin or plasticizer migration in the aged coating. Overcoats with a high degree of internal stress will transfer their strong internal forces to the underlying aged coating which may cause spontaneous delamination of the entire system.

In addition to coating-to-coating compatibility, the overcoat system must also be compatible with, and adhere to, the substrate. The present project focuses on two distinct types of surfaces: galvanized steel (hangars and control tower) and steel (deluge tanks).

The Army uses preformed architectural metal sections in the construction of buildings, including aircraft hangars and building components such as roofs. These items are often galvanized or Galvalume™ coated. Zinc or zinc/aluminum alloy coated steel is sometimes purchased as is, without an organic coating system. Such items may be field painted for aesthetic reasons either when new or after a period of years. Delamination is the primary mode of failure of coatings applied to new and aged galvanized steel. The failure mechanism involves alkaline hydrolysis of the coating and subsequent loss of adhesion. Historically, acid and zinc chromate containing wash primers have been used to assure adhesion of subsequent top coats. However, because of the health and environmental hazards associated with hexavalent chromium compounds and the high volatile organic compound content of wash primers, these products have lost favor within the marketplace.

Large welded or bolted steel fabrications such as water tanks and structural steel are rarely galvanized. More typically, steel structures are painted with alkyd, epoxy, and polyurethane coatings. Historically, the Army used lead-containing primers with alkyd or oleo resinous topcoats. Most industrial maintenance coating systems are designed for adhesion over clean steel surfaces. However, some coatings are more tolerant of minimally prepared steel surfaces that have adherent mill scale and rust. These types of products are generally preferred for overcoating painted steel structures.

Epoxy primer/fluoropolymer topcoat

One objective of a previous Army research project was to evaluate the performance of selected commercially available coating systems for use on new and aged galvanized steel substrates. Laboratory testing was performed to evaluate fitness-for-purpose as measured by adhesion before and after exposure in a test cabinet with alternating wet (dilute electrolyte fog) and dry cycles. Coatings were selected to represent the range of available technologies including: acrylic/acrylic; acrylic/alkyd; epoxy/polyurethane; and epoxy/fluoropolymer. Pre- and post-exposure adhesion values were used to indicate fitness-for-purpose of coatings applied to hot-dip metal coated steel. Low values are consistent with the primary mode of failure of coatings on these substrates, which is delamination or spontaneous peeling. Initial and final adhesion values of ASTM D3359 *Standard Test Methods for Measuring Adhesion by Tape Test*, Me-

thod B (3.0 B) are indicative of coatings that are performing at an acceptable level for this application.

Adhesion test results indicate that acrylic/acrylic and acrylic/alkyd systems do not meet the fitness-for-purpose criteria. However, systems using an epoxy primer have superior adhesion and are appropriate for use on weathered galvanized and galvalumed steel substrates.

Table 4. Performance of selected coating systems over nonferrous metal substrates.

Paint System	Average Dry Film Thickness (mils)		Adhesion: Galvanized Steel		Adhesion: Galvalumed Steel	
	Primer	System	Initial	Final	Initial	Final
Epoxy/Fluoropolymer	2.3	3.5	5.0 B	4.4 B	5.0 B	5.0 B
Acrylic/Acrylic	1.8	4.0	0.8 B	1.2 B	0.3 B	0.0 B
Acrylic/Acrylic	3.1	5.4	2.1 B	0.8 B	3.4 B	2.3 B
Acrylic/Alkyd	2.0	4.4	0.0 B	3.4 B	1.1 B	2.5 B
Epoxy/Polyurethane	1.8	3.9	4.4 B	4.4 B	5.0 B	5.0 B

The primary function of coatings for use over hot-dip coated architectural building panels is preservation of appearance. Appearance attributes include gloss and color retention and resistance to chalking.

Fluorinated polymers are recognized as the most durable coatings in terms of preservation of appearance. Architectural building panels with factory applied polyvinylidene fluoride coating are available with standard 20- and 30-year warranties covering appearance properties. Air dry fluoropolymer coatings have emerged as a premium recoat product for factory installed polyvinylidene fluoride coatings as well as to use for other weathered coatings. Air dry fluoropolymer coatings are also used in conjunction with epoxy primers for application to weathered hot-dip coated steel.

Air dry fluoropolymer coatings do not have the proven history of factory applied polyvinylidene fluoride coatings. However, their durable life can be estimated based on the durability of these products and manufacturers' claims. A reasonable estimate from these sources indicates a durable life of 20 to 25 years. Recoating with the same topcoat or a similar material would be necessary at the end of the durable life in order to restore its ap-

pearance. Functional life, in terms of adhesion and corrosion protection offered by the underlying hot-dip coating, should be considerably longer.

Moisture cure polyurethane

Moisture cured polyurethanes (MCU) are a popular and successful group of overcoat materials. They are available in a wide range of colors and pigmentations. Versions containing micaceous iron oxide are popular and provide excellent barrier properties. MCU are tolerant of relatively poor application conditions and generally can be applied at very high humidity and low temperatures. They are quite versatile and have performed well in the NEPCOAT overcoat study. MCU overcoat systems have been recommended for use on Corps of Engineers projects.

MCU overcoat systems were previously demonstrated and validated under the Environmental Security Technology Certification Program. Aluminum pigmented MCU was tested on a complex steel lattice railroad bridge at Holston Army Ammunition Plant. The projected service-life of the MCU overcoat repair was reported to be 12 to 18 years. The projection was based on the pre-overcoat condition of the original paint system, the durability of the overcoat materials, and the severity of the exposure environment. A variety of differently pigmented MCU systems were applied as test patches to the exterior of a steel deluge tank at Fort Campbell. The projected service-life of the overcoat repair on the tank was reported to be 15 to 25 years. Both projects successfully validated the cost performance of MCU overcoat systems.

Self-healing smart coatings

Self-healing smart coatings incorporate microcapsules, which are mixed into paint as a dry powder at the time of application. Microcapsules may instill the coating with special properties including self-healing, corrosion resistance, and passive sensing.

Research has established that constituents of microcapsules can be released when they are ruptured by damage to the coating in which they are contained (Sarangapani et al. 1999; Kumar and Stephenson 2002, 2003, 2004; Stephenson and Kumar 2003; Kumar et al. 2006; Koene et al. 2005; U.S. Patent US 2006/0042504A1, March 2006; U.S. Patent COE Case #558, March 2003).

The investigated microcapsules exhibited long-term stability in dried paint films, only releasing active constituents when ruptured.

The optimum microcapsules were found to have nominal diameters in the range of 60 to 150 microns. Large diameter microcapsules are better at delivering their functional constituents. However, microcapsules diameters should not be greater than the paint thickness.

Because of its resistance to many of the commonly used paint solvents, urea formaldehyde (UF) was found to be the best shell material for containing the functional compounds for self-healing smart and corrosion resistance. UF shells also have good resistance to the functional compounds that they contain and exhibit long-term stability in dried paint films. UF shells are relatively easy to break and allow release of their constituents as needed.

Environmental, health, and safety practices for overcoating

Surface contaminants may be removed by power washing or hand washing. Power washing pressures should be limited such that substantial amounts of lead-containing paint are not removed. Wash water should be collected and tested for lead contamination. For elevated work or work over water, suspended netting may provide adequate environmental protection provided this practice is acceptable to local regulators. Alternatively, hand washing minimizes the amount of waste generated and, therefore, may be selected on this basis. Hand-wash water is readily collected on ground tarps because of the relatively small volume.

Wash water that exhibits the hazardous characteristic must be disposed of as a hazardous waste. Filtering the solids from collected water may be sufficient to reduce the hazardous characteristic. Waste water from power washing averages 100 to 200 gallons per 1000 ft^2 of surface cleaned. Waste water from hand washing averages 10 to 20 gallons per 1000 ft^2 of surface cleaned.

Abrasive blasting is not recommended for the preparation of surfaces for overcoating in part because of the lead-containing dust that is generated.

Vacuum shrouded power tools are recommended for preparing corroded areas and to remove loose coating. Vacuum shrouds reduce worker exposure to lead-containing dust and reduce the chance of environmental re-

leases as well. Ground tarps should be used in conjunction with vacuum shrouded tools.

Health and safety requirements are generally the same for overcoating projects as for other industrial maintenance painting projects and include fall protection, flammable liquid precautions, hearing conservation, eye protection, and respiratory protection. Additional requirements may be necessary depending on whether workers are exposed to lead above the action level during surface preparation activities. Half-face respirators with an Assigned Respiratory Factor (APF) of 10 are recommended for use during cleaning with vacuum-assisted power tools. A greater degree of respiratory protection may be required if vacuum assist is not employed. Personal air monitoring (PAM) should be conducted at the outset of any project involving the removal of lead-containing paint to ensure that workers are adequately protected.

Residual dust produced during power tool cleaning must be removed from the surface prior to overcoating. Wiping down surfaces with rags wet with water or solvent is recommended as it reduces worker exposures to lead-containing dust. When solvents are used, they should have a high flash point.

Table 5 summarizes the recommended environmental and worker protection practices.

Table 5. Summary of recommended worker health and environmental protection practices.

Procedure	Environmental Protection	Worker Health Protection
Contaminant Removal	Collect wash and rinse waters on ground tarps and test for lead. Filter water if appropriate. Use nets for debris collection as a minimum for elevated work.	Hearing and eye protection
Surface Preparation	Vacuum shrouded power tools	Respirators with minimum APF of 10. Hearing and eye protection.
Dust Removal	Wet rags to prevent dust dispersion	NA
Overcoat Application	NA	Respirators as necessary. Eye protection.

Results

Structures selected for overcoating

Table 6 describes the structures evaluated and selected for overcoating.

Table 6. Structures overcoated.

Name	Building No.	Surface Area	Overcoating
Hangar #1	Bldg. 7161	16,401 SF	Moisture cure polyurethane
Hangar #2	Bldg. 7156	30,654 SF	Moisture cure polyurethane
Flight Control Tower	Bldg. 7212	8,250 SF	Epoxy Primer Fluoropolymer Topcoat
Sabre Deluge Tank	Bldg. 6623A	5,806 SF	Moisture cure polyurethane
Destiny Deluge Tank	Bldg A7219	6,287 SF	Moisture cure polyurethane with self healing coatings
Total Area Painted		67,398 SF	

Overcoating risk assessment: initial condition of structures

The initial condition of the structures selected for maintenance painting at Fort Campbell is detailed below. Structures were rated for corrosion, flaking, erosion, and adhesion. The presence of hazardous lead and chromium was determined. The initial condition is important because it has a direct bearing on what work practices are employed as well as the extent and, therefore, cost of cleaning and surface preparation. The initial condition is included in this report to help the reader understand the applicability of the work practices employed herein and the relevance of the cost data to other prospective projects. The initial condition of the coated structures is depicted by some of the photographs contained in Appendix B. Data sheets for total hazardous metals measured in the preexisting coatings are shown in Appendix C. Fourier transform infrared (FTIR) spectrographs indicative of generic coating type of preexisting paints are shown in Appendix D and are discussed below.

Hangar #1

Hangar #1 is a galvanized corrugated steel structure. The initial paint condition was generally poor with widespread areas of peeling on the siding.

Flaking (or scaling) was rated in accordance with ASTM D 772. Degree of flaking on the siding was dependent on location and ranged from No. 0 (total) to No. 4. The hangar doors were in good condition, having been recently overcoated. Degree of flaking was No. 10 (none) on the hangar doors.

The preexisting white colored paint was identified by FTIR spectroscopy as either a short oil alkyd or polyester. The backsides of sampled paint chips are a light greenish color. The chemical composition of the material responsible for the light green color could not be determined. However, the color and substrate type are consistent with the presence of vinyl butyral wash primer. Wash primer is known to contain chromium. However, total chromium in the paint was measured at only 0.025%. Lead content was also insignificant at 0.0083%. Windows, hangar doors, and door frames are steel and were previously primed with TT-P-86 Type1 Red Lead Primer.

Where the existing coating was still intact on the siding, dry film thickness was generally 2 to 3 mils. Door frames and windows had 5 to 8 mils of paint. The paint thickness on the hangar doors was not measured.

Coating adhesion on the siding was consistently poor at 0A. Coating adhesion on door frames and windows was not measured because of size constraints.

The galvanizing was still protecting the siding from corrosion with only minor amounts of rust noted on some of the flashing around the windows. The steel windows and door frames had minor amounts of rust (less than 5%).

Hangar #1 was not considered a candidate for overcoating. Large areas of coating had already delaminated, probably as a result of saponification. The remaining coating had poor adhesion (0A) and overcoat failure was considered to be a certainty. The removal of essentially all of the coating on the galvanized steel siding of Hangar #1 was specified.

Hangar #2

Hangar #2 is a corrugated galvanized steel structure with steel hangar doors, windows, and appurtenances. The overall initial paint condition of the structure was good. The hangar doors were recently overcoated.

The degree of rusting (ASTM D 610) on the siding was 8 to 7 (0.1 to 0.3%). Steel windows and entryway doorframes were in generally poorer condition with rust ratings of 4 to 3 (10 to 16%) and 5 to 1 (3 to 50%), respectively. The exterior staircase had a rust rating of 4 to 3 (10 to 16%). The hangar doorframes had a rust rating of about 5 (3%).

The degree of flaking on the siding was generally No. 9 or better. The degree of flaking on steel door frames and windows ranged from No. 4 to No. 8. The degree of flaking on the exterior staircase was about No. 2.

The dry film thickness on the siding was 2 to 8 mils. The dry film thickness on the windows, doorframes, and exterior staircase were 3 to 8 mils, 8 to 16 mils, and 6 to 9 mils, respectively.

The paint adhesion on the siding ranged from 0A to 5A. Poor areas of adhesion seemed to be localized. Steel substrates, such as doorframes, had adhesion values of 3A to 4A.

Steel appurtenances including windows, door frames, stairs, and hangar doors were previously painted with red lead primer. Total lead in one sample taken from a door frame was 37%. Door frames and hangar doors have intact mill scale. With the exception of the hangar doors and entryway doors, the topcoat is an aluminum pigmented tung oil phenolic paint. The galvanized steel did not appear to have a primer. However, it is highly probable that the galvanizing received an application of vinyl butyral wash primer prior to application of the aluminum pigmented tung oil phenolic topcoat. Tests for lead and chromium in paint chips from the siding showed negligible levels of each (0.064% Pb and 0.0041% Cr).

The low coating thickness, smooth galvanized substrate, and variable adhesion (0A to 5A) indicated that the risk of overcoating the corrugated shell of this structure varied from low to certain. The presence of mill scale, paint thickness (thin to medium), and paint adhesion (3A to 4A) on steel appurtenances (windows, doorframes, staircase) indicated that the risk that overcoating would fail on these surfaces is low. However, the extensive corrosion on some of the doorframes indicated that these few items were not candidates for overcoating. It would be more cost effective to remove all of the coating and repaint these items.

Control tower

The control tower is a corrugated galvanized steel structure. The overall initial paint condition was fair. There were two coats of paint on the structure. The primer appeared to be an alkyd. The topcoat was either a short oil alkyd or polyester. Presumably, the structure was pretreated with vinyl butyral wash primer. This is a safe assumption because alkyds are incompatible with galvanizing and will saponify if applied directly to the substrate. There was evidence that saponification had occurred because peeling and blistering were exhibited in patterns consistent with spray application. In other words, the original application of wash primer was deficient because coverage of the substrate was incomplete.

The rust rating for the structure ranged from 7 to 6 (0.3 to 1%). Most of the visible rust was pinpoint rust appearing in areas with significant erosion of the topcoat and/or primer. Additional corrosion was visible in areas where the paint had delaminated due to saponification.

Erosion of the topcoat was rated a No. 6 (20 to 25% primer showing). In addition to the topcoat erosion, about 1 to 3% of the primer has eroded exposing the galvanized substrate. The paint dry film thickness generally ranged from 1 to 3 mils. The adhesion ranged from 2A to 5A. Lead and chromium content were negligible at 0.072% and 0.061%, respectively.

The coating thickness (thin), galvanized substrate (smooth), and adequate adhesion (2A to 5A) indicated low to moderate risk for overcoating the control tower.

Destiny deluge tank

The Destiny deluge tank is a welded plate steel structure. The structure was previously painted only once in its 40-year service life. The original system consisted of abrasive blasting and application of TT-P-86 Type 2 red lead paint and TT-P-38 aluminum pigmented tung oil phenolic topcoat. The dry film thickness was 3.5 to 5.5 mils.

The tank was in generally poor condition with significant amounts of paint erosion and corrosion. The corrosion rating of the tank shell was about a 3 (16%). Topcoat erosion was significant with numerous areas of red primer showing. The degree of topcoat erosion was No. 8 (5%). In some areas, the

primer had eroded enough for general corrosion to occur. Flaking of the topcoat was not an issue on this structure.

Total lead in one paint chip sample measured a significant 8%. Actual lead content is probably higher as the measured quantity was probably low because the sample was scraped rather than taken as a whole chip. Paint adhesion was generally very good and averaged 4A.

The low coating thickness and good adhesion (4A) both indicate that there was not a significant risk associated with overcoating the shell of the tank. However, the percent area corroded (16%) approaches the cut-off point of 17% where overcoating is not as cost-effective as complete removal and repainting. The tank roof was not a candidate for overcoating because of the extensive degradation.

Sabre deluge tank

The Sabre deluge tank is a welded plate steel structure. The structure had been previously painted only once in its 30-year service life. The original system consisted of abrasive blasting and application of TT-P-86 Type 2 red lead paint and TT-P-38 aluminum pigmented tung oil phenolic topcoat. The dry film thickness was 1.8 to 4.8 mils.

The tank shell was in fair condition with minor amounts of paint erosion and corrosion. The rust rating for the tank shell was 6 to 5 (1 to 3%). The estimated rust rating for the tank roof was 4 to 2 (10 to 33%). The degree of topcoat erosion on the tank shell was No. 9 (1%). No paint was flaking on the tank shell. However, flaking was extensive on the roof drainpipe and the tie-off ring at the top of the tank shell. The drainpipe, ladder, and ladder cage had extensive corrosion and rated a 2 (33%) or worse.

Total lead in one paint chip sample measured a significant 8%. Actual lead content is probably higher as the measured quantity was probably low, because the sample was scraped rather than taken as a whole chip. Paint adhesion was generally very good and averaged 4A.

The low coating thickness and good adhesion (4A) indicated that the risk associated with overcoating the shell of this tank was negligible. The extent of corrosion (1 to 3%) was low, indicating that the economics of overcoating the shell were good. The extent of flaking and corrosion on the tank

roof, ladder and cage, drainpipe, and tie-off ring were high and exceeded the threshold at which overcoating is no longer cost-effective.

Project specifications

The painting specifications are summarized in Tables 7 through 10. HPW is high pressure washing. WFT and DFT are wet and dry film thickness, respectively. Chembuild and Hydroflon are brand names of Tnemec. Corothane is a Sherwin-Williams brand. LBP is lead-based paint.

Table 7. Hangars #1 and #2.

Work Process	
Surface Preparation and Cleaning	HPW @ 1500-5000 psi - to remove loose paint, chalk, and dirt. Spot clean SSPC-SP 3 Power Tool Clean to remove rust and loose paint. Spot clean lifted areas after priming SSPC-SP 2 Hand Tool Clean.
Environmental Controls	Impermeable ground tarps overlaid with semi-permeable ground tarps
Primer	Corothane I Mastic 4.0-5.5 mils WFT 2.5-3.5 mils DFT
Finish Coat	Corothane I HS Aliphatic 3.5-5.0 mils WFT 2.0-3.0 mils DFT

Table 8. Control tower.

Work Process	
Surface Preparation and Cleaning	HPW @ 1500-5000 psi - to remove loose paint, chalk, and dirt. Spot clean SSPC-SP 3 Power Tool Clean to remove rust and loose paint. Spot clean lifted areas after priming SSPC-SP 2 Hand Tool Clean.
Environmental Controls	Impermeable ground tarps overlaid with semi-permeable ground tarps
Primer	Tnemec Series 135 Chembuild 5.0-7.0 mils WFT 4.0-6.0 mils DFT
Finish Coat	Tnemec Series 701 Hydroflon 3.0-5.0 mils WFT 2.0-3.0 mils DFT

Table 9. Destiny deluge tank.

Work Process	
Surface Preparation and Cleaning	HPW @ 1500-5000 psi - to remove loose paint, chalk, and dirt. Spot clean SSPC-SP 3 Power Tool Clean to remove rust and loose paint. Spot clean lifted areas after priming SSPC-SP 2 Hand Tool Clean.

Environmental Controls	Impermeable ground tarps overlaid with semi-permeable ground tarps
Primer	Corothane I Mastic 4.0-5.5 mils WFT 2.5-3.5 mils DFT
Finish Coat	Corothane I HS Aliphatic 3.5-5.0 mils WFT 2.0-3.0 mils DFT NOTE: Ladder rungs and lower 12 inches of tank finish coated with self-healing anti-corrosive paint composed of a mixture of 30 weight percent microcapsules in Corothane I HS Aliphatic.

Table 10. Sabre deluge tank.

Work Process	
Surface Preparation and Cleaning	HPW @ 1500-5000 psi - to remove loose paint, chalk, and dirt. Spot clean SSPC-SP 3 Power Tool Clean to remove rust and loose paint. Spot clean lifted areas after priming SSPC-SP 2 Hand Tool Clean.
Environmental Controls	Impermeable ground tarps overlaid with semi-permeable ground tarps
Primer	Corothane I Mastic 4.0-5.5 mils WFT 2.5-3.5 mils DFT
Finish Coat	Corothane I HS Aliphatic 3.5-5.0 mils WFT 2.0-3.0 mils DFT

Project work practices

Overcoating work practices are depicted in photographs contained in Appendix B. Manufacturer product data sheets of the paints used on the project are contained in Appendix E.

Hangars #1 and #2

Containment and surface preparation

Soil testing was conducted before surface preparation by gathering soil from the foot of each hangar. Soil samples were tested for lead at an approved laboratory. The purpose of the tests was to determine the lead content in the soil before and after pressure washing.

Prior to power washing, the ground was covered with 4-mil thick plastic sheeting extending 8 feet from the exterior walls of the hangars. Polyvinyl chloride (PVC) pipe was wrapped in the plastic to form a dam and prevent water from spilling on the ground. In addition to plastic sheeting, perforated tarps were laid over the impermeable plastic to collect paint chips

while simultaneously allowing water to pass through. Collected water was evaporated. After power washing, the paint chips and plastic sheeting were disposed of as special waste.

Surface preparation

All exterior siding was power washed at 2400 psi to remove dirt, loose paint, oxidation, and other contaminants per the specification. After power washing, areas that showed surface rust and remaining loose paint were prepared according to SSPC-SP3. Additional surface preparation was performed after the primer was applied in areas where existing paint lifted. These areas were hand-tool cleaned in accordance with SSPC-SP2 and spot primed. All signage was removed and reinstalled after the final coat was applied.

Installation of coating system

After surface preparation, one coat of Sherwin Williams Corothane I Mastic was applied by brush and roll application to an average dry film thickness of 4 mils. Lifted areas that were hand-tool cleaned were then primed a second time.

After the primer was applied and allowed to cure in accordance to manufacturer's requirements, one coat of Sherwin Williams Corothane I HS Aliphatic Finish Coat was applied to the exterior siding, entry doors, doorframes, and stairway to an average dry film thickness of 3.5 mils.

Safety

In accordance with the Manta Safety Program, all employees were drug screened, fit tested for respiratory protection equipment, and trained by the Manta competent person in the use of hazardous material Material Safety Data Sheets (MSDS) and special equipment.

Safety audits and tool box safety meetings were conducted weekly by Manta Field and Office Supervision to evaluate potential risks and hazards (KARRS). These programs were conducted per Manta's Industrial Safety Program and Fort Campbell Safety Policy to eliminate potential accidents during normal work procedures.

Sabre and Destiny deluge tanks

Containment of possible hazardous material

Soil testing was conducted before surface preparation by gathering soil from the foot of each tank. Soil samples were tested for lead at an approved laboratory. The purpose of the tests was to determine the lead content in the soil before and after pressure washing.

Prior to power washing the tanks, the ground was covered with 4-mil thick plastic sheeting extending 8 feet from the tanks. PVC pipe was wrapped in the plastic to form a dam and prevent water from spilling on the ground. In addition to plastic sheeting, perforated tarps were laid over the impermeable plastic to collect paint chips while simultaneously allowing water to pass through. Collected water was evaporated. After power washing, the paint chips and plastic sheeting were disposed of as special waste.

Surface preparation

All exterior tank surfaces were power washed at 2400 psi to remove dirt, loose paint, oxidation, and other contaminants per the specification. After power washing, any areas that showed surface rust or remaining loose paint were prepared according to SSPC-SP3. Additional surface preparation was performed after the primer was applied in areas where existing paint lifted. These areas were hand-tool cleaned in accordance with SSPC-SP2 and spot primed. All signage was removed and reinstalled after the final coat was applied.

Installation of coating system

After surface preparation, one coat of Sherwin Williams Corothane I Mastic was applied by brush and roll application to an average of dry film thickness of 4 mils. Lifted areas that were hand-tool cleaned were then primed a second time.

After the primer was applied and allowed to cure in accordance with the manufacturer's requirements, one coat of Sherwin Williams Corothane I HS Aliphatic Finish Coat was applied to the exterior of the tank to an average dry film thickness of 3.5 mils.

A small installation of an experimental self-healing smart coating was accomplished on the Destiny deluge tank. Ladder rungs and the lower 12

inches of the tank shell were finish coated with a self-healing and anti-corrosive paint composed of a mixture of 30 weight percent microcapsules in Corothane I HS Aliphatic. The composition of the microcapsules is given in Table 11.

Table 11. Composition of microcapsules for self-healing smart paint.

Microcapsule Description	EM000808A (urea-formaldehyde shell, 60-150 micron diameter)
Diluent	Therminol 66 (modified partially hydrogenated terphenol) 18.5 Percent by Weight
Diluent	Santicizer 148 (Isodecyl diphenyl phosphate) 19.4 Percent by Weight
Film-Former	phenolic varnish 55.3 Percent by Weight
Antioxidant	butylated hydroxytoluene (BHT) 0.43 Percent by Weight
Anticorrosion Agent	Irgacor 153 (alkylammonium salt of (2-benzothiazolylthio) succinic acid in xylene preparation 6.1 Percent by Weight

Safety

In accordance with the Manta Safety Program, all employees were drug screened, fit tested for respiratory protection equipment, and trained by the Manta competent person in the use of hazardous material MSDS and special equipment.

Safety audits and tool box safety meetings were conducted weekly by Manta Field and Office Supervision to evaluate potential risks and hazards (KARRS). These programs were conducted per Manta's Industrial Safety Program and Fort Campbell Safety Policy to eliminate potential accidents during normal work procedures.

Flight Control Tower

Containment and washing

Soil testing was conducted before surface preparation by gathering soil from the foot of each hangar. Soil samples were tested for lead at an ap-

proved laboratory. The purpose of the tests was to determine the lead content in the soil before and after pressure washing.

Prior to power washing, the ground was covered with 4-mil thick plastic sheeting extending 8 feet from the exterior walls of the tower. PVC pipe was wrapped in the plastic to form a dam and prevent water from spilling on the ground. Perforated tarps were laid over the impermeable plastic to collect paint chips while simultaneously allowing water to pass through. Collected water was evaporated. After power washing, the paint chips and plastic were disposed of as special waste.

Surface preparation

All exterior tank surfaces were power washed at 2400 psi to remove dirt, loose paint, oxidation and other contaminants per the specification. After power washing, any areas that showed surface rust and remaining loose paint were prepared according to SSPC-SP3. Additional surface preparation was performed after the primer was applied in areas where existing paint lifted. These areas were hand tool cleaned in accordance with SSPC-SP2 and spot primed. All signage was removed and reinstalled after the final coat was applied.

Installation of coating system

After surface preparation one coat of Tnemec Series 135 Chembuild was applied by brush and roll application to all exterior siding, catwalk, doors and frames to an average dry film thickness of 3.5 mils. Lifted areas that were further prepared by hand-tool cleaning were then primed a second time.

After the primer was applied and allowed to cure in accordance with the manufacturer's requirements, one coat of Tnemec Series 701 Hydroflon (fluoropolymer) was applied by brush and roll application to all exterior siding, catwalk, doors, and frames to an average dry film thickness of 3.5 mils.

Safety

In accordance with the Manta Safety Program, all employees were drug screened, fit tested for respiratory protection equipment, and trained by

the Manta competent person in the use of hazardous material MSDS and special equipment.

Safety audits and tool box safety meetings were conducted weekly by Manta Field and Office Supervision to evaluate potential risks and hazards (KARRS). These programs were conducted per Manta's Industrial Safety Program and Fort Campbell Safety Policy to eliminate potential accidents during normal work procedures.

4 Metrics

Inspections of the surface-tolerant coating work performed at Fort Campbell under this demonstration project were conducted by an independent contractor. A copy of the final inspection report is attached as Appendix F.

To ascertain that the coatings are performing their function of corrosion protection, steel coupons mounted on racks were exposed to determine atmospheric corrosion rates. The corrosion rates will be determined at 6 month intervals. In addition, the racks contained 3 steel coupons with each type of coating that was demonstrated under this project. The performance of these coating systems will be evaluated at 6-month intervals. Each of these self-healing smart coatings will be scribed at 6-month intervals to ascertain the effectiveness of the self-healing smart microcapsules. During a prior project in 2002, a deluge tank was coated with a moisture-cure urethane coating system similar to the coating systems used in this project (Race et al. 2003). The coating system on that deluge tank has performed well during the past 3 years. Comparison to this structure can be used to demonstrate longer-term performance.

5 Economic Summary

Unit area costs

Unit area costs for overcoating are summarized in Tables 12 through 14. The average cost of overcoating 1 ft^2 of surface at Fort Campbell was $3.16.

Table 12. Hangars 1 and 2 with moisture cure polyurethane.

Work Phase	Hours	Production (ft^2/hour)
Mobilization/Demobilization	37	NA
Washing	124	379
Power Tool Cleaning	32	1470
Primer	469	100
Finish Coat	468	100
Cost	\$/ft^2	Percent of Cost
Mobilization/Demobilization	0.054	2
Surface Preparation	0.793	32
Paint Application	1.355	55
Paint & Expendables (est.)	0.269	11
Total Cost	2.47	100

Table 13. Flight control tower with fluoropolymer finish coat.

Work Phase	Hours	Production (ft^2/hour)
Mobilization/Demobilization	24	NA
Washing	12	687
Power Tool Cleaning	160	52
Primer	232	36
Finish Coat	232	36
Cost	\$/ft^2	Percent of Cost
Mobilization/Demobilization	0.156	3
Surface Preparation	0.940	17
Paint Application	2.405	43
Paint & Expendables (est.)	2.057	37
Total Cost	5.558	100

Table 14. Deluge tanks with self-healing smart primer and moisture cure polyurethane.

Work Phase	Hours	Production (ft^2/hour)
Mobilization/Demobilization	24	NA
Washing	24	504
Power Tool Cleaning	80	151
Primer	36	336
Finish Coat	36	336
Cost	$/$ft^2$	Percent of Cost
Mobilization/Demobilization	0.348	8
Surface Preparation	1.512	36
Paint Application	1.542	37
Paint & Expendables (est.)	0.807	19
Total Cost	4.209	100

Cost variability

An analysis was performed to assess cost variability. The major cost variables are mobilization/demobilization, surface preparation, paint application, and materials. The cost of mobilization/demobilization ranged from \$0.054/ft^2 to \$0.348/ft^2. The cost of surface preparation ranged from \$0.793/ft^2 to \$1.512/ft^2. The cost of paint application ranged from \$1.355/ft^2 to \$2.405/ft^2. The cost of paint and expendable materials ranged from \$0.269/ft^2 to \$2.057/ft^2. Based on the available data low and high costs of overcoating are calculated to be \$2.47/ft^2 and \$6.32/ft^2 respectively. The median calculated cost of overcoating is \$4.39/ft^2. The cost variability is $\pm$ \$1.92/ft^2 or $\pm$ 44%.

Cost comparison

The cost of overcoating the structures at Fort Campbell can be compared to the cost of complete coating removal and repainting.

The paint systems used for overcoating are similar or the same as those that may have been used to repaint the structures had all of the preexisting paint been removed prior to painting. Therefore, application and material costs would have been similar or the same as for overcoating. The primary cost differential between overcoating and complete paint removal and repaint is surface preparation.

The hangars could not be abrasive blasted because blasting creates dust that is incompatible with the functions of the hangars. Additionally, the best alternative to abrasive blasting these structures is ultra high pressure

(UHP) water blasting. Assuming production rates in the range of 80 to 100 ft^2/h, the added cost of complete coating removal on the hangars would have been $1.60/$ft^2$ to $2.19/$ft^2$. UHP water blasting would have increased the cost by about 65 to 90%. This increase is exclusive of any increased mobilization/demobilization costs.

Similarly, the flight tower could not be abrasive blasted because blasting creates dust that is incompatible with its function. The best alternative to abrasive blasting the tower is UHP water blasting. Assuming production rates in the range of 30 to 50 ft^2/h, the added cost of complete coating removal on the tower would have been $0.34/$ft^2$ to $0.86/$ft^2$. UHP water blasting would have increased the cost by about 5 to 15%. This increase is exclusive of any increased mobilization/demobilization costs.

The deluge tanks could have been contained and dry abrasive blasted to remove the existing coating prior to repainting. Assuming production rates in the range of 150 to 200 ft^2/h, the cost of complete coating removal on the tanks would have been about the same to $0.29/$ft^2$ less in terms of production. However, the additional costs of containment, worker protection, and waste disposal would have increased the cost by about $3/$ft^2$ to $5/$ft^2$. Overall the cost of abrasive blasting would have been about 65 to 120% higher. A summary comparison of the median cost of overcoating to the cost of coating removal and repainting is presented in Table 15.

Table 15. Comparison of cost of overcoating vs. paint removal and repainting.

Activity	Overcoating Median Cost ($/ft^2)	Coating Removal Repainting Median Cost ($/ft^2) with UHP Blasting	Coating Removal Repainting Median Cost ($/ft^2) with UHP Blasing & Abrasive Blasting
Mobilization/Demobilization	0.19	0.19	0.19
Surface Preparation	1.08	1.75	1.75
Containment	N/A	N/A	1.33
Paint Application	1.77	1.77	1.77
Paint & Expendibles	1.29	1.29	1.29
TOTAL	**4.39**	**5.00**	**6.33**

Projected return on investment

The projected ROI for this project was determined by assessing the project costs and projected cost avoidance due to implementation of the surface

tolerant coatings in accordance with the recommended procedure based on Appendix B of OMB Circular A94. Based on the results of this project, the ROI has been projected to be 11.8. Assumptions that support this project ROI are given in Appendix A. The ROI calculation was validated by an analysis by Mark 10 Resource Group, Inc., which also is included in Appendix A. The results of this implementation and demonstration project have validated this ROI projection.

6 Recommendations

The technology implemented at Fort Campbell validates the use of surface tolerant overcoatings and self-healing smart coatings. Guidance and standards for use of surface tolerant coatings and self-healing smart coatings at other locations, and under varying conditions, should be developed.

It is recommended that UFGS 09900 "Paints and Coatings" and UFGS 09920S "Painting and Coating" be revised based on the results of this project.

7 Implementation

It is recommended that the Army and DoD use surface tolerant coatings, self-healing coatings, and fluoropolymer coatings as a standard practice for the overcoating of steel structures. It is further recommended that existing Unified Facilities Guide Specifications, Engineering Instructions, Technical Instructions, Technical Manuals, and specifically UFGS 09900 and UFGS 09920S be revised to include overcoating specifications and instructions for installing these surface tolerant coatings.

8 Conclusions

Based on the field testing of these technologies at Army installations, advanced coating selection and implementation of overcoating will provide the benefits of restoring structures to their optimum operating conditions, as well as reducing maintenance costs, and increasing safety. For example, fire suppression systems utilizing deluge tanks will remain operational and, therefore, training and operations flights will not be grounded. Safety is increased when self-healing smart coatings help protect critical components. Timely maintenance utilizing surface tolerant coatings for overcoating will reduce overall maintenance costs compared to total coating removal and replacement.

The surface tolerant coating technologies are commercially available and ready for implementation as solutions to the corrosion problems on hangars, flight control towers, deluge tanks, and other types of suitable steel structures.

References

American Society for Testing and Materials (ASTM) D 610 Standard Test Method for Evaluating Degree of Rusting on Painted Steel Surfaces.

ASTM D 772 Standard Test Method for Evaluating Degree of Flaking (Scaling) of Exterior Paints.

ASTM D 3359 Standard Test Methods for Measuring Adhesion by Tape Test, Method B.

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SSPC-SP 3 Power Tool Cleaning

SSPC-SP 11 Power Tool Cleaning to Bare Metal

SSPC-VIS 3, Visual Standard for Power- and Hand-Tool Cleaned Steel

Stephenson, L. D. and Ashok Kumar. "Technology Demonstration of Self-Healing Coatings for In-Place Management of Lead-Based Paint Hazards," Technical Report, 20 Jul 2004, ERDC/CERL, Champaign, IL, Report Number ERDC/CERL TR-03-29.

U. S. Patent: "Self-Healing Coatings Using Microcapsules," Pub Number US 2006/0042504A1, Published 2 March 2006.

U. S. Patent: "Self-Healing Paints" (COE Case # 558) filed on 04 March 2003.

Appendix A: ROI Analysis and Validation

Assumptions and calculations

Alternative 1: Surface tolerant coatings will be used on 25 steel structures in the Army over the next 5 years at a cost of $67,000 per structure. However, the current technology for removal of the lead-based paint (LBP) is ultra-high pressure water blasting at a cost of $80,400 per structure (up to 120% higher than the cost of painting). After removal of the LBP, a new painting system will be installed at a cost of $67K (about $5/square foot) per steel structure per year over a 5-year period, with 5 structures being stripped and repainted each year. The following annual costs will be incurred: $402K for abrasive blasting of the lead based paint per steel structure per year, $335K for repainting per steel structure per year, and $10K per unstripped steel structure per year for maintenance of the old paint systems until the structures can be stripped and repainted. The total costs for each year are shown under *Baseline Costs*. Also, environmental penalties each year for the "unstripped" warehouses will be $100K per steel structure, requiring stripping per year as shown under *New System Benefit/Savings*. Details are also shown in the Detailed Cost worksheet.

Alternative 2: The cost of using the surface tolerant overcoatings on the first five steel structures as demonstrated under this project at Fort Campbell, is included in the project cost of $740K. The cost of stripping and repainting the remaining 20 steel structures will be paid as operational cost and are shown as part of *New System Costs* at a cost of $67K per structure ($335K for five structures). *Maintenance* is $5K per overcoated structure per year. In the remaining 4 years, the cost of environmental violations/cleanup of lead hazards from the unstripped structures will be avoided, as shown under *New System Benefits/Savings*, ranging from $2.5 M in the first year to $500K in Year 5, i.e., $100K per unstripped structure. Details are also shown in the Detailed Cost worksheet.

Comparing the two alternatives, the potential ROI for Alternative 2 is projected to be 11.8.

Investment Required			**740,000**
Return on Investment Ratio	**11.81**	**Percent**	**1181%**
Net Present Value of Costs and Benefits/Savings	**1,354,149**	**10,091,712**	**8,737,564**

A **Future Year**	**B** **Baseline Costs**	**C** **Baseline Benefits/Savings**	**D** **New System Costs**	**E** **New System Benefits/Savings**	**F** **Present Value of Costs**	**G** **Present Value of Savings**	**H** **Total Present Value**
1	987,000		25,000	2,500,000	23,365	3,258,950	3,235,585
2	937,000		385,000	2,000,000	336,259	2,565,176	2,228,917
3	887,000		410,000	1,500,000	334,683	1,948,508	1,613,825
4	837,000		435,000	1,000,000	331,862	1,401,447	1,069,586
5	787,000		460,000	500,000	327,980	917,631	589,651
6	-		-	-	-	-	-

	Old System Cost						New System Cost			Benefits
Years	Number of Steel Structures	Number to be painted	Painting	UHP Water Blasting	Maintenance	Total	Overcoating	Maintenance	Total	Penalties /Cleanup Avoidance
1	25	5	$335,000	$402,000	$250,000	$987,000	$0	$25,000	$25,000	$2,500,000
2	20	5	$335,000	$402,000	$200,000	$937,000	$335,000	$50,000	$385,000	$2,000,000
3	15	5	$335,000	$402,000	$150,000	$887,000	$335,000	$75,000	$410,000	$1,500,000
4	10	5	$335,000	$402,000	$100,000	$837,000	$335,000	$100,000	$435,000	$1,000,000
5	5	5	$335,000	$402,000	$50,000	$787,000	$335,000	$125,000	$460,000	$500,000

Independent validation and analysis

Preface

MARK 10 Resource Group, Inc.

11641 Drysdale Drive, Richmond, VA 23236 Phone: (804) 379-2676 Fax: (804) 379-2521

December 17, 2006

Mr. Charlie Gibbs S&K Technologies 309 Osigian Blvd. Warner Robins, GA 31088

RE: OSD Project: AR-F-320 ROI – Verification and Validation Report

Mr. Gibbs,

MARK 10 Resource Group, Inc. has examined and evaluated the ROI projections provided in the Final Report for CPC Project AR-F-320. MARK 10 Resource Group's review and conclusions are contained in this report. The purpose of the AR-F-320 project was to demonstrate and implement cost-effective maintenance painting procedures for steel structures, including overcoating existing coatings, with surface tolerant, self-healing, and extremely durable coatings.

Independent ROI analysis

The primary purpose of this independent ROI verification by MARK 10 Resource Group, Inc. was to determine if the costs contained within the projected ROI for future projects, based on the costs and projected savings for the work performed and the coating systems applied at Ft. Campbell on these five structures, are consistent with prevailing industry costs for this type of work. This review included verifying the assumptions and projections contained within the projected ROI regarding the projected life of the structure, the costs associated with removal of lead-based paints, the costs associated with the surface preparation and application of coatings to the structures and the projected maintenance costs.

The second purpose of this ROI verification is to determine if the current condition of the coating systems applied on the structures at Ft. Campbell

provides any indication, after one year of service, that the projected thirty-year life, with occasional maintenance repairs, will not be obtained.

After reviewing the Final Report provided for this project, including the ROI and the accompanying documentation, MARK 10 Resource Group, Inc. has determined that the ROI projections and calculations appear reasonable and consistent with industry costs and associated service life projections, therefore MARK 10 Resource Group, Inc. hereby validates the ROI projections and associated projected costs and cost savings.

Report on the contractor's work and the coating systems used

The work performed on CPC Project AR-F-320 serves as the basis for the ROI calculations for future work on similar structures. In reference to the Ft. Campbell structures, MARK 10 Resource Group, Inc. performed three quality assurance inspections of the work performed by Manta Industrial Coatings for AR-F-320: Surface-Tolerant Coatings for Aircraft Hangars, Flight Control Tower, and Deluge Tanks at Fort Campbell.

The first quality assurance inspection by MARK 10 Resource Group, Inc., occurred in September 2005, after the primer was applied to all structures except the flight control tower. MARK 10 Resource Group, Inc., provided details of this inspection to ERDC/CERL in a report, entitled In-Progress Inspection Report, dated May 30, 2006.

The second quality assurance inspection, conducted by MARK 10 Resource Group, Inc. took place in October 2005, after all the coatings were applied to all five structures. A detailed report, entitled Final Inspection Report, was furnished to ERDC/CERL on June 2, 2006.

The third quality assurance inspection, conducted by MARK 10 Resource Group, Inc, took place in November 2006, approximately one-year after Manta Industrial completed the coating application work. This inspection included a visual assessment of the coating systems, mechanical rubbing the coatings to determine if chalk was present and measuring the dry film thickness. Based on the results obtained during this one-year, post-application inspection, MARK 10 Resource Group, Inc., determined that all three coating systems selected for evaluation and applied by Manta Industrial Coatings, are performing very well at this time, with no visible indication of chalking, loss of gloss, film degradation, or film thickness loss.

A summary of the dry film thickness measurements obtained at the completion of the project and at the one-year, post-inspection is contained in the table below.

Table 1: Avg. Dry Film Thickness Readings - Final Inspection vs. 1 Year Post-Application

Structure Name (Building Number)	Avg. DFT – October '05 (Number of Gage Readings) Final Inspection	Avg. DFT – November '06 (Number of Gage Readings) 1-year Post-Completion
Hangar #1 (Bldg. 7161)	9.8 mils (329 gage readings)	9.7 mils (330 gage readings)
Hangar #2 (Bldg. 7156)	14.8 mils (600 gage readings)	14.9 mils (600 gage readings)
Flight Control Tower (Bldg. 7212)	5.9 mils (285 gage readings)	6.6 mils (300 gage readings)[1]
Sabre Deluge Tank (Bldg. 6623A)	8.7 mils (299 gage readings)	8.8 mils (300 gage readings)
Destiny Deluge Tank (Bldg. A7219)	7.7 mils (300 gage readings)	8.4 mils (300 gage readings)[2]

Notes Regarding Table 1:

(1). The one-year, post-application dry film thickness measurements on the Flight Control Tower are higher than the final inspection dft values, obtained one year earlier. Manta Industrial applied additional coating film thickness after the final inspection dft readings were recorded to repair areas where the final inspection report indicated that the coatings were damaged and required repair.

(2). Microcapsule self-healing paint was applied to the bottom portion of the Destiny Deluge Tank after the final inspection dft readings were obtained; thereby increasing the total dry film thickness in these areas and contributing to the 0.7 mil dft overall increase in the dft.

MARK 10 Resource Group, Inc. is currently preparing its report of the one-year, post-application inspection performed by MARK 10 in November 2006. It is anticipated that this report will be completed in January 2007.

Respectfully Submitted,

Mike O'Brien President – MARK 10 Resource Group, Inc. NACE Certified International Coating Inspector #2484

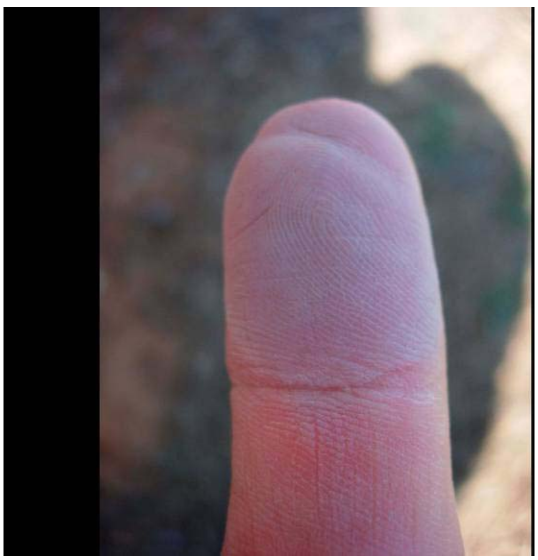
Appendix B: Project Photographs









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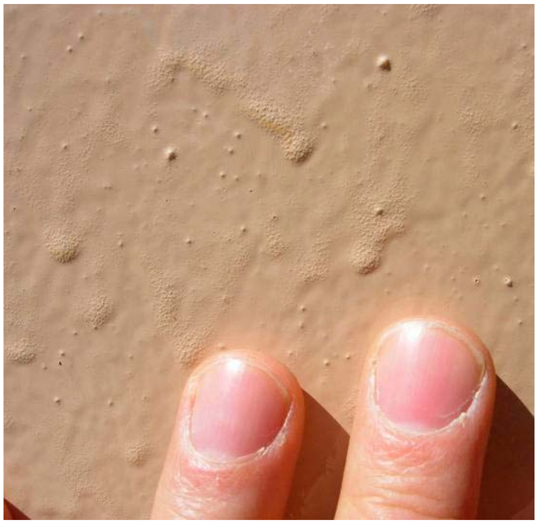

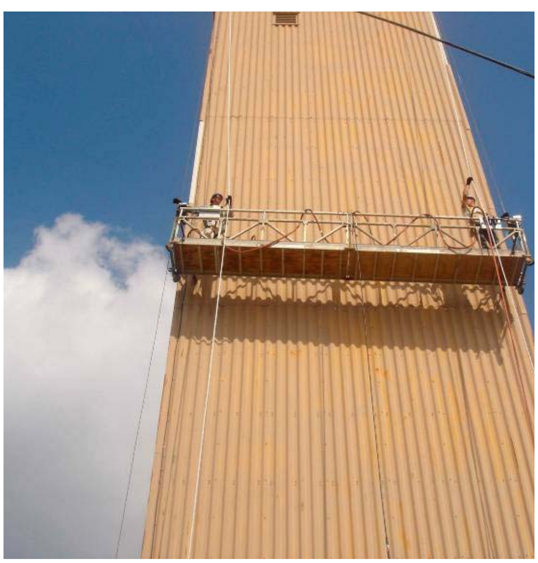


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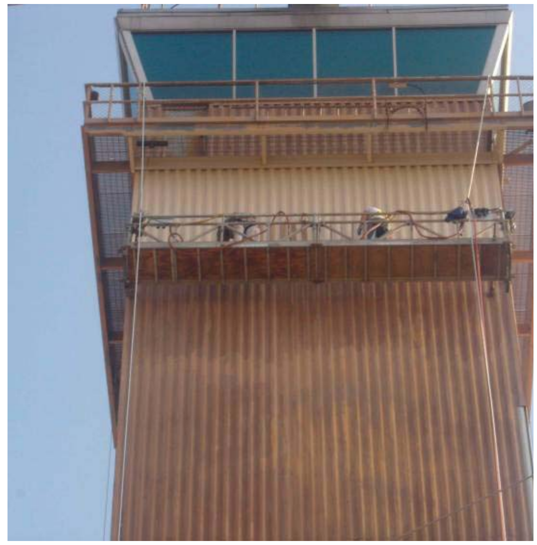
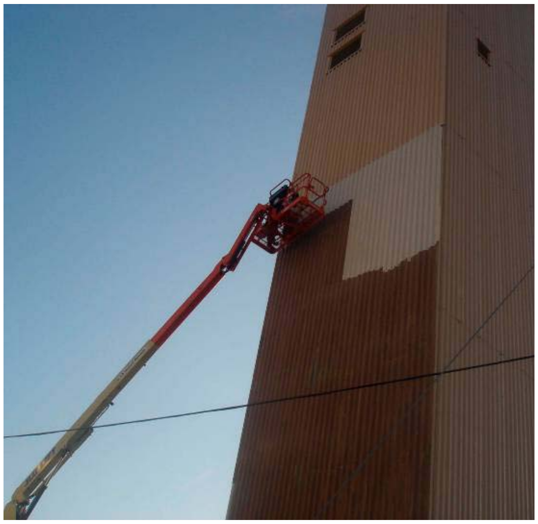
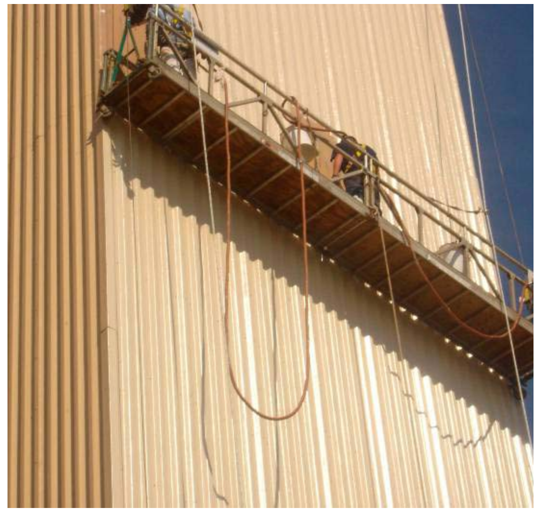
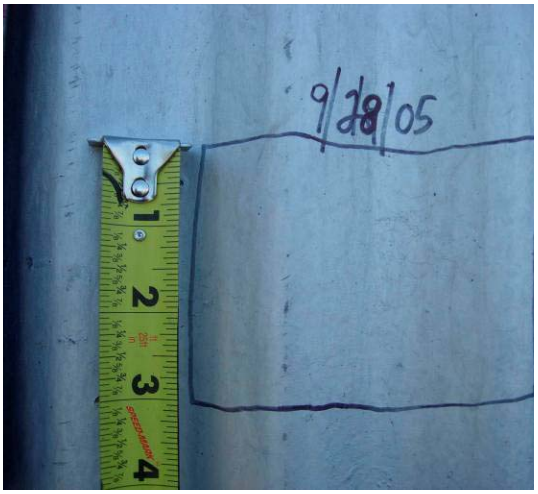





DURA NY-Coat™
by Komelon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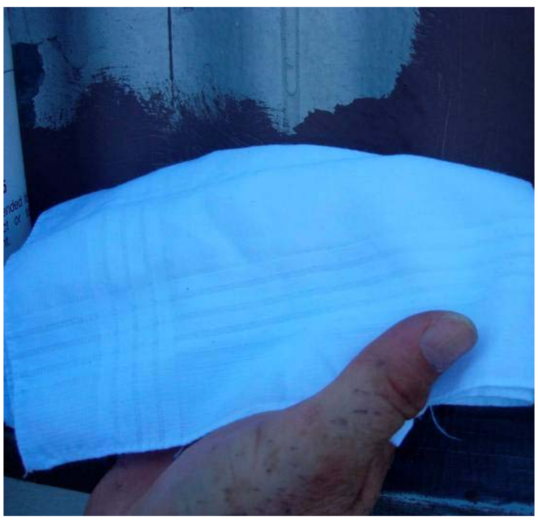
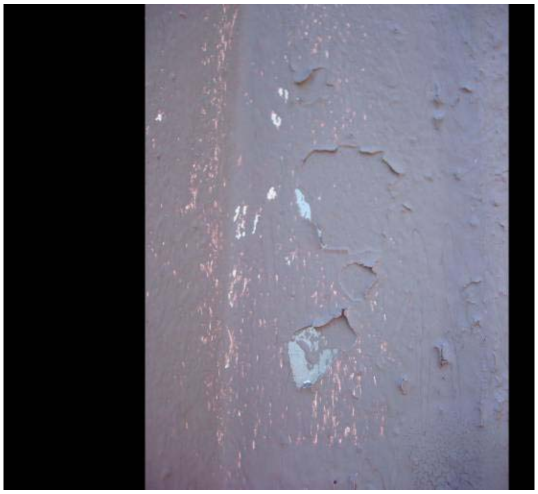


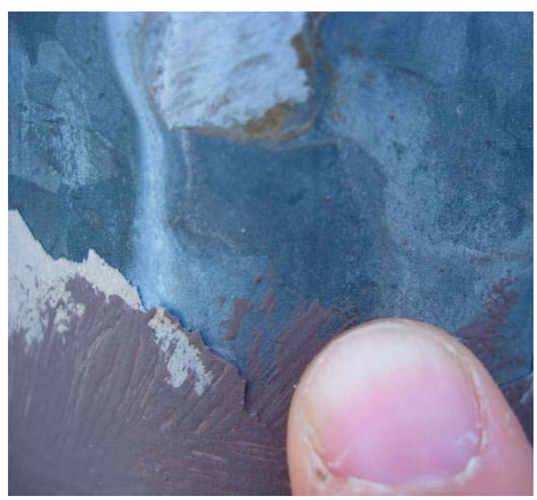




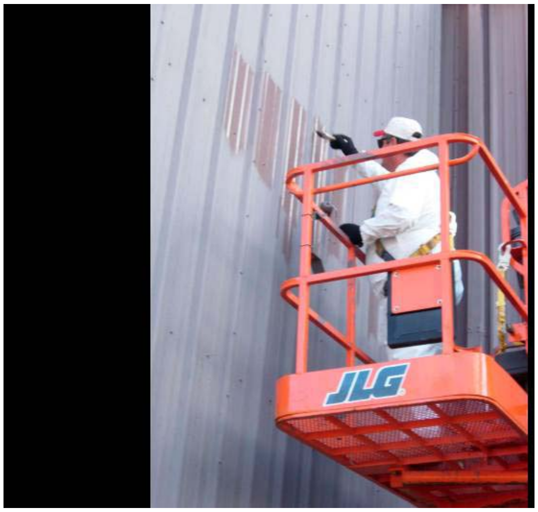




DANGER
EXPLOSIVE CARTRIDGES
INSTALLED


NO SMOKING



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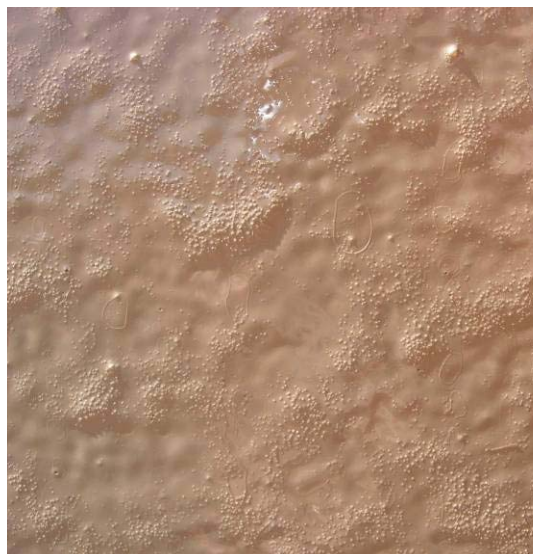
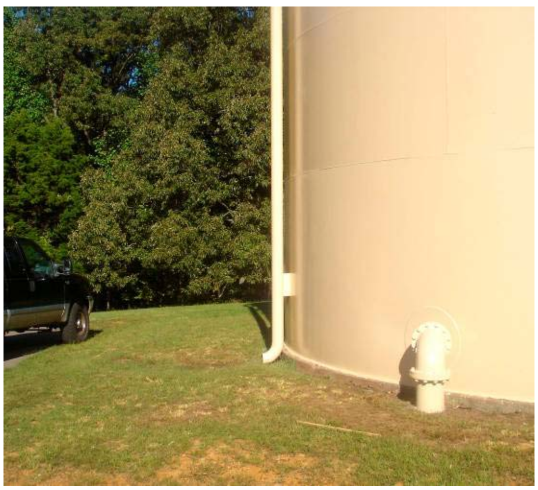
DIESEL





Appendix C: Datasheets for Pre-existing Coatings

CORROSION • CONTROL • CONSULTANTS • AND LABS, INC.

ANALYTICAL LABORATORY REPORT

Tuesday, March 08, 2005

CLIENT: Corrosion Control Consultants and Lab -TR
135 Addison Avenue / Suite 108
Elmhurst, IL 60126

DATE RECEIVED: Thursday, March 03, 2005
DATE COMPLETED: Friday, March 04, 2005
PO/PROJECT #:
INVOICE #: 30555

Preparation Method: EPA 600/R-93/200M-P (Total Metals in Paint Chips, Sonication)
Analysis Method: EPA 6010B (ICP-AES Method for Determination of Metals)

LAB NUMBER: 05- 2849

Sampled By:
Job Location:
Sample Identification: TDR-1 Sabre deluge
Date Sampled:
Sample Description: Paint Chips

ELEMENT	RESULT (by weight)	REPORTING LIMIT
Lead	**8.3 %**	0.0050 %

LAB NUMBER: 05- 2853

Sampled By:
Job Location:
Sample Identification: TDR-5 Destiny deluge
Date Sampled:
Sample Description: Paint Chips

ELEMENT	RESULT (by weight)	REPORTING LIMIT
Lead	**8.2 %**	0.0050 %

Unless Otherwise Noted: 1.) All Of The Quality Control Meets The Requirements.
2.) The Condition Of Each Sample Was Acceptable Upon Receipt

Test Reviewed By: Sarah Frank Olthof, QA Manager

*Not Detected At The Reporting Limit

Sarah Frank Olthof

Corrosion Control Consultants & Labs, Inc. Is AIHA Accredited In The Environmental Lead Program For Paint, Soil, Dust Wipes And Air; And In The Industrial Hygiene Program For Metals.

ANALYTICAL LABORATORY REPORT

Tuesday, March 08, 2005

CLIENT: Corrosion Control Consultants and Lab -TR
135 Addison Avenue / Suite 108
Elmhurst, IL 60126

DATE RECEIVED: Thursday, March 03, 2005
DATE COMPLETED: Friday, March 04, 2005
PO/PROJECT #:
INVOICE #: 30555

Preparation Method: EPA 600/R-93/200M-P (Total Metals in Paint Chips, Sonication)
Analysis Method: EPA 6010B (ICP-AES Method for Determination of Metals)

LAB NUMBER: **05-2850**

Sampled By:
Job Location:
Sample Identification: TDR-2 Hangar #1 (7161) resin type
Date Sampled:
Sample Description: Paint Chips

ELEMENT	RESULT (by weight)	REPORTING LIMIT
Lead	**0.0083 %**	0.0050 %
Chromium	**0.025 %**	0.0013 %

LAB NUMBER: **05-2851**

Sampled By:
Job Location:
Sample Identification: TDR-3 Hangar #2 (7156)
Date Sampled:
Sample Description: Paint Chips

ELEMENT	RESULT (by weight)	REPORTING LIMIT
Lead	**0.064 %**	0.0081 %
Chromium	**0.0041 %**	0.0020 %

LAB NUMBER: **05-2852**

Sampled By:
Job Location:
Sample Identification: TDR-4 Hangar #2 (7156)
Date Sampled:
Sample Description: Paint Chips

ELEMENT	RESULT (by weight)	REPORTING LIMIT
Lead	**37 %**	0.0050 %
Chromium	**0.029 %**	0.0013 %

LAB NUMBER: **05-2854**

Sampled By:
Job Location:
Sample Identification: TDR-6 Control tower resin type
Date Sampled:
Sample Description: Paint Chips

ELEMENT	RESULT (by weight)	REPORTING LIMIT
Lead	**0.072 %**	0.0050 %
Chromium	**0.061 %**	0.0013 %

ANALYTICAL LABORATORY REPORT

Tuesday, March 08, 2005

CLIENT: Corrosion Control Consultants and Lab -TR
135 Addison Avenue / Suite 108
Elmhurst, IL 60126

DATE RECEIVED: Thursday, March 03, 2005
DATE COMPLETED: Friday, March 04, 2005
PO/PROJECT #:
INVOICE #: 30555

Preparation Method: EPA 600/R-93/200M-P (Total Metals in Paint Chips, Sonication)
Analysis Method: EPA 6010B (ICP-AES Method for Determination of Metals)

Unless Otherwise Noted: 1.) All Of The Quality Control Meets The Requirements.
2.) The Condition Of Each Sample Was Acceptable Upon Receipt

Test Reviewed By: Sarah Frank Olthof, QA Manager

*Not Detected At The Reporting Limit

Sarah Frank Olthof

Corrosion Control Consultants & Labs, Inc. Is AIHA Accredited In The Environmental Lead Program For Paint, Soil, Dust Wipes And Air; And In The Industrial Hygiene Program For Metals.

Appendix D: FTIR Spectrographs of Pre-existing Paints

Mr. Tim Race
CCC&L
135 Addison Avenue, Suite 108
Elmhurst, IL 60126

March 4, 2005
Project J05030

Subject – Generic Identification of Paint Chip Samples

Dear Mr. Race,

In accordance with your request, Weldon Laboratories, Inc. has analyzed two paint chip samples by infrared spectroscopy to determine the generic type of coating.

Samples

The following were received from CCC&L on March 3, 2005:

No.1 – Paint chips labeled "TDR2, Hanger #1".
No.2 – Paint chips labeled "TDR6, Control Tower".

Laboratory Investigation

The laboratory investigation consisted of infrared spectroscopy, performed with a Mattson Polaris Model fourier transform infrared spectrometer. The technique involved combining sample scrapings with potassium bromide powder and forming into pellets under high pressure. The pellets were then placed in the optical path of the spectrometer, and spectra obtained over the range 4000-400 cm^{-1}.

Three spectra were obtained and are appended. Briefly, the analysis revealed the following:

No.1 – The white topcoat from Sample No.1 is either a short oil alkyd or a polyester, as indicated by bands near 2900, 1725, 1460, 1255, 1120, and 1070 cm^{-1}. The relatively strong, broad band near 1595 cm^{-1} is not typical of an alkyd or polyester, and could possibly be due to carboxylic acid salts, which are often an indication of saponification. These chips also had an extremely thin light greenish coat on the back. This coat could not be analyzed due to the chips being very small and the greenish coat being extremely thin. Its color and appearance suggested that it might be a vinyl wash primer.

No.2 – The powdery layer on the back side of Sample No.2 appears to be an alkyd. The very strong band near 1550 cm^{-1} could be due to saponification.

No.3 – The tan topcoat from Sample No.2 is either a short oil alkyd or a polyester.

Summary

Two paint chip samples were analyzed by infrared spectroscopy for generic identification. Sample No.1 had an extremely thin light greenish coat on the back of it which could not be tested.

If you have any questions or comments, please do not hesitate to contact this office.

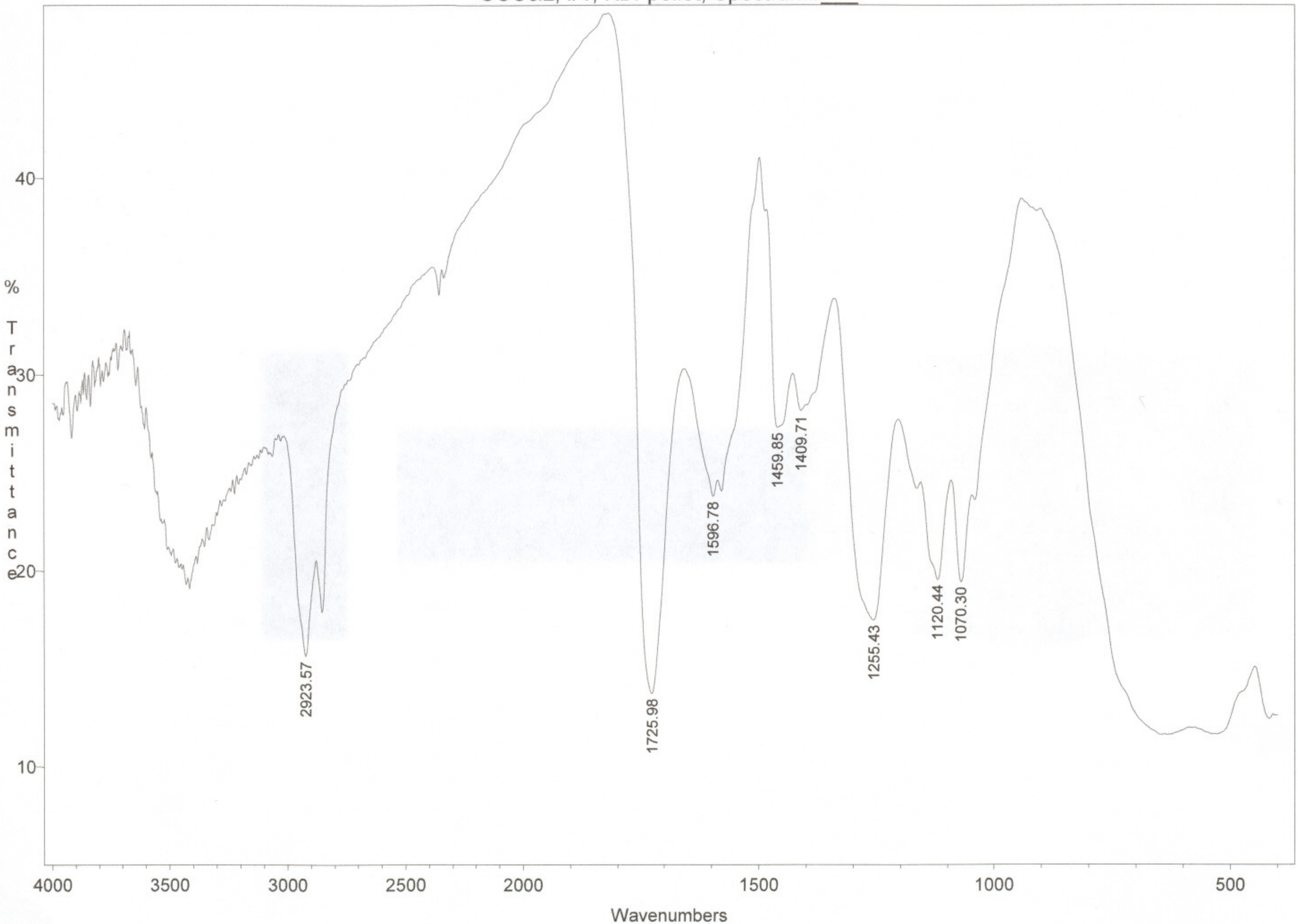
Sincerely,

Dwight G. Walden

Index of Infrared Spectra

No.1 – Sample No.1, white topcoat.
No.2 – Sample No.2, powdery layer on back.
No.3 – Sample No.2, topcoat.

CCC&L, #1, KBr pellet, Spectrum# 1

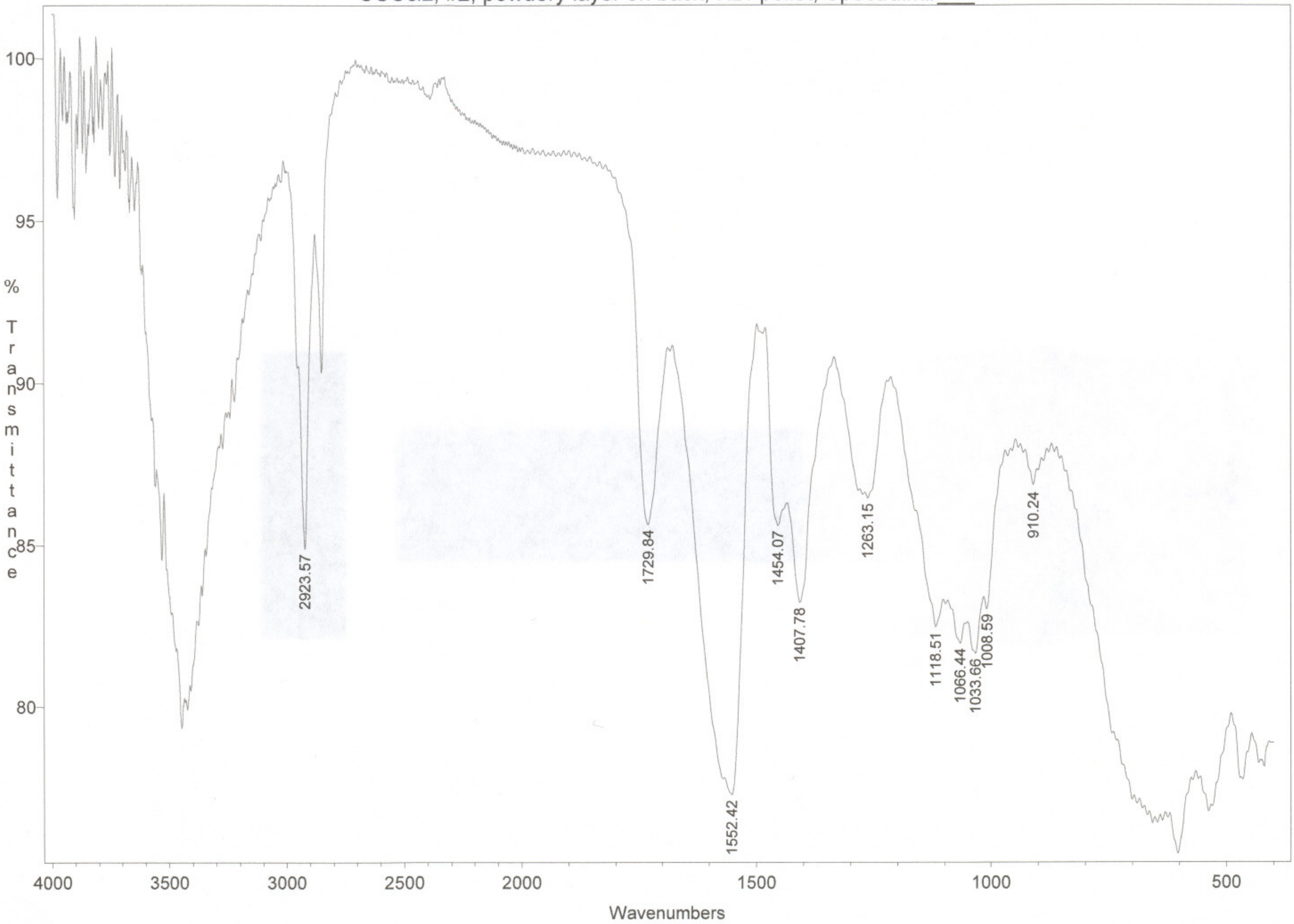


Operator: dgw
Resolution: 4.0

Company: Weldon Laboratories, Inc.

Scans: 32
Date: Thu Mar 03 14:31:48:44 2005

CCC&L, #2, powdery layer on back, KBr pellet, Spectruim# 2

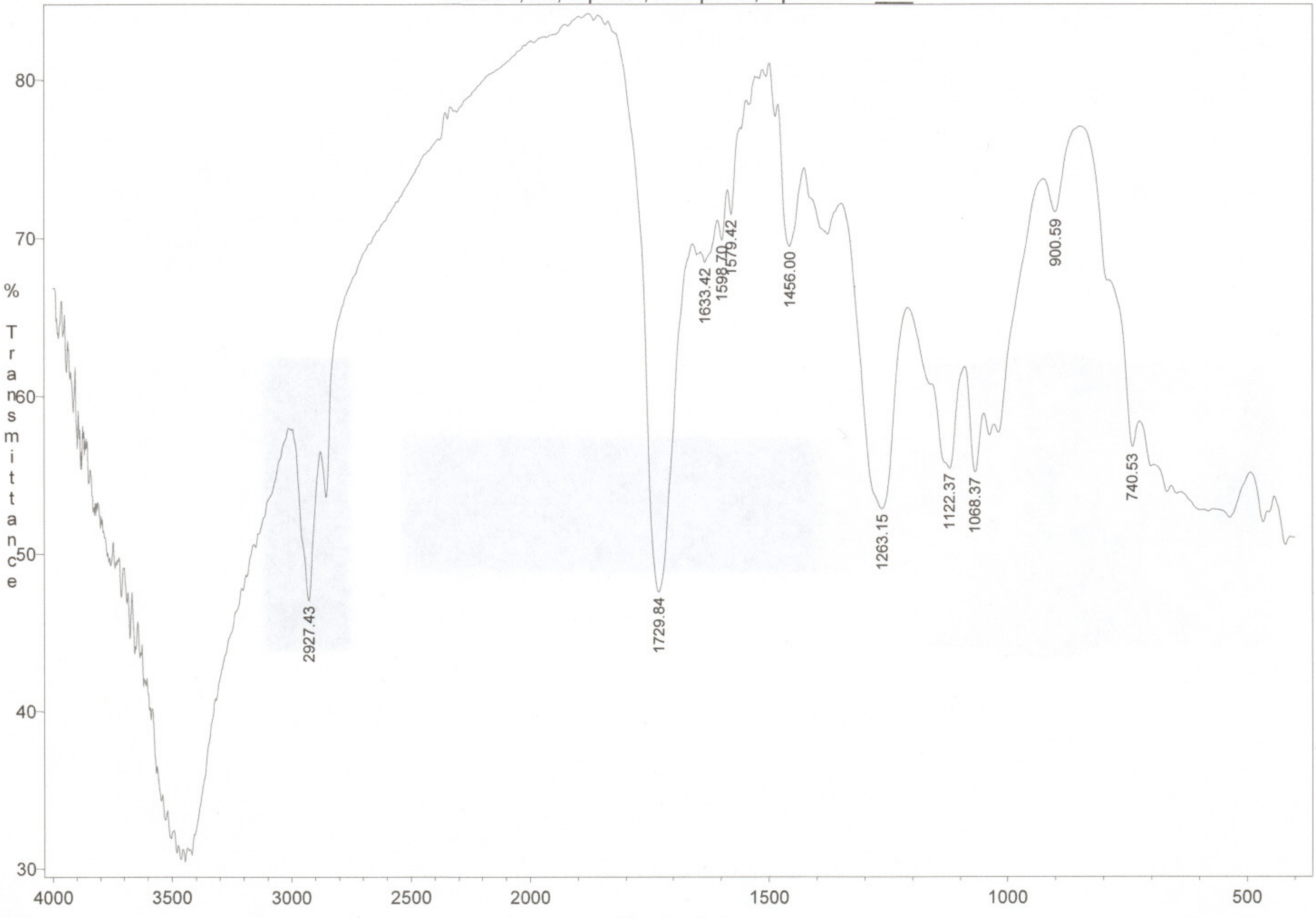


Operator: dgw
Resolution: 4.0

Company: Weldon Laboratories, Inc.

Scans: 32
Date: Fri Mar 04 09:53:47:73 2005

CCC&L, #2, topcoat, KBr pellet, Spectrum# 3



Operator: dgw
Resolution: 4.0

Company: Weldon Laboratories, Inc.

Scans: 32
Date: Fri Mar 04 10:06:12:73 2005

Appendix E: Manufacturer Data Sheets for Project Paints

Industrial
&
Marine
Coatings

5.12

COROTHANE® I HS

ALIPHATIC FINISH COAT

B65-50 Series

PRODUCT INFORMATION

Revised 4/06

Product Description

COROTHANE I HS is a single component, VOC compliant, moisture curing urethane designed for low temperature or high humidity applications while providing UV resistance and chemical resistance equivalent to two part urethane coatings.

- Low temperature application - down to 20°F
- Superior resistance to yellowing, chalking, or degradation by sunlight
- Superior adhesion to most prepared surfaces
- Superior abrasion resistance
- Outstanding chemical resistance
- VOC compliant
- One component

Recommended Uses

- Color coat where maximum color and gloss retention are required
- Suitable for use in the following industries:
  - Marine
  - Industrial
  - Bridge and Highway
  - Water and Waste Water
  - Petro-Chemical
  - Pulp and Paper
  - Rail
  - Suitable for use in USDA inspected facilities.
  - Conforms to AWWA D102-03 OCS #2

Product Characteristics

Finish: Gloss

Color: Wide range of colors available

Volume Solids: 61% ± 1%, may vary by color

Weight Solids: 77% ± 2%

VOC (EPA Method 24):
Unreduced: <340 g/L; 2.8 lb/gal
Reduced 5% <360 g/L; 3.0 lb/gal

Recommended Spreading Rate per coat:

Wet mils:	3.5 - 5.0
Dry mils:	2.0 - 3.0
Coverage:	326 - 489 sq ft/gal approximate

Drying Schedule @ 4.0 mils wet @ 50% RH:

	@ 40°F	**@ 77°F**	**@ 100°F**
To touch:	4 hours	2 hours	45 minutes
To recoat:			
minimum:	24 hours	12 hours	6 hours
maximum:	14 days	14 days	14 days
To cure:	7 days	3 days	3 days

If maximum recoat time is exceeded, abrade surface before recoating. Drying time is temperature, humidity, and film thickness dependent.

Shelf Life: 12 months, unopened
Store indoors at 40°F to 100°F.
(Tinted colors must be used within 7 days after tinting)

Flash Point: 101°F, Seta Flash

Reducer/Clean Up: Reducer #15, R7K15, or Aromatic 100 Reducer, R2K5

Performance Characteristics

System Tested: (unless otherwise indicated)
Substrate: Steel
Surface Preparation: SSPC-SP6
1 ct: Corothane I MIO-Aluminum @ 3.0 mils dft
1 ct: Corothane I HS @ 3.0 mils dft

Abrasion Resistance:
Method: ASTM D4060, CS17 wheel, 1000 cycles, 1 kg load
Result: 80 mg loss

Adhesion:
Method: ASTM D4541
Result: 1296 psi

Corrosion Weathering:
Method: ASTM D5894, 12 cycles, 4032 hours
Result: Rating 10 per ASTM D610 for rusting
Rating 10 per ASTM D714 for blistering

Direct Impact, topcoat only:
Method: ASTM D2794
Result: 70 in lb

Flexibility, topcoat only:
Method: ASTM D522, 180° bend, 1/8" mandrel
Result: Passes

Humidity:
Method: ASTM-D4585, 1000 hours
Result: Rating 10 per ASTM D610 for rusting
Rating 10 per ASTM D714 for blistering

Pencil Hardness:
Method: ASTM D3363
Result: HB

Salt Fog Resistance:
Method: ASTM B117, 1000 hours
Result: Rating 10 per ASTM D610 for rusting
Rating 10 per ASTM D714 for blistering

Thermal Cycling :
Method: ASTM D2246, 15 cycles
Result: Passes, no cracking, checking, or blistering; no loss of adhesion; 100% gloss retention

Meets requirements of SSPC Paint 38, Level II.

continued on back

Industrial
&
Marine
Coatings

COROTHANE® I HS

ALIPHATIC FINISH COAT

B65-50 SERIES

PRODUCT INFORMATION

RECOMMENDED SYSTEMS

Steel:
1 ct. Corothane I MIO-Aluminum @ 2.0 - 3.0 mils dft
1 ct. Corothane I Ironox B @ 3.0 - 5.0 mils dft
1 ct. Corothane I HS @ 2.0 - 3.0 mils dft

Steel:
1 ct. Corothane I MIO-Aluminum @ 2.0 - 3.0 mils dft
1-2 cts. Corothane I HS @ 2.0 - 3.0 mils dft/ct

Steel:
1 ct. Corothane I GalvaPac Zinc Primer @ 3.0 - 4.0 mils dft
1 ct. Corothane I Ironox B @ 3.0 - 5.0 mils dft
1 ct. Corothane I HS @ 2.0 - 3.0 mils dft

Steel:
1 ct. Corothane I PrePrime @ 1.0 - 1.5 mils dft
1 ct. Corothane I MIO-Aluminum @ 2.0 - 3.0 mils dft
1 ct. Corothane I Ironox B @ 3.0 - 5.0 mils dft
1 ct. Corothane I HS @ 2.0 - 3.0 mils dft

Steel (Epoxy Primer):
1 ct Dura-Plate MT @ 6.0 - 8.0 mils dft
1-2 cts Corothane I HS Coat @ 2.0 - 3.0 dft/ct

Concrete, smooth:
1 ct. Corothane I PrePrime @ 1.0 - 1.5 mils dft
1 ct. Corothane I HS @ 2.0 - 3.0 mils dft

Concrete, rough:
On deeply profiled or damaged concrete floor:
1 ct. Kem Cati-Coat HS Epoxy Filler/Sealer @ 10.0 - 20.0 mils dft/ct, as required to fill voids and provide a continuous substrate.
1 ct. Corothane I HS @ 2.0 - 3.0 mils dft

Previously Painted Surfaces:
Spot prime bare steel with 1 coat of Corothane I GalvaPac Zinc Primer
1 ct. Corothane I HS @ 2.0 - 3.0 mils dft
or
1 ct. Corothane I Ironox B @ 3.0 - 5.0 mils dft
1 ct. Corothane I HS @ 2.0 - 3.0 mils dft
(Check compatibility)

The systems listed above are representative of the product's use. Other systems may be appropriate.

SURFACE PREPARATION

Surface must be clean, dry, and in sound condition. Remove all oil, dust, grease, dirt, loose rust, and other foreign material to ensure adequate adhesion.

Refer to product Application Bulletin for detailed surface preparation information.

Minimum recommended surface preparation:

* Iron & Steel:	SSPC-SP6/NACE 3
* Concrete & Masonry:	SSPC-SP13/NACE 6, or ICRI 03732, CSP 1-3
Previously Painted	SSPC-SP2 or SP3

* Primer required

TINTING

Tint B65W51 and B65T54 only with 844 colorants, 100% tint strength. Must be used within 7 days after tinting.

APPLICATION CONDITIONS

Temperature:	
air and surface:	20°F minimum, 100°F maximum
material:	45°F minimum Do not apply over surface ice
Relative humidity:	Can be applied at relative humidities up to 99%.

Refer to product Application Bulletin for detailed application information.

ORDERING INFORMATION

Packaging:	1 and 5 gallon containers
Weight per gallon:	11.79 ± 0.2 lb, may vary by color.

SAFETY PRECAUTIONS

Refer to the MSDS sheet before use.

Published technical data and instructions are subject to change without notice. Contact your Sherwin-Williams representative for additional technical data and instructions.

DISCLAIMER

The information and recommendations set forth in this Product Data Sheet are based upon tests conducted by or on behalf of The Sherwin-Williams Company. Such information and recommendations set forth herein are subject to change and pertain to the product offered at the time of publication. Consult your Sherwin-Williams representative to obtain the most recent Product Data Information and Application Bulletin.

WARRANTY

The Sherwin-Williams Company warrants our products to be free of manufacturing defects in accord with applicable Sherwin-Williams quality control procedures. Liability for products proven defective, if any, is limited to replacement of the defective product or the refund of the purchase price paid for the defective product as determined by Sherwin-Williams. NO OTHER WARRANTY OR GUARANTEE OF ANY KIND IS MADE BY SHERWIN-WILLIAMS, EXPRESSED OR IMPLIED, STATUTORY, BY OPERATION OF LAW OR OTHERWISE, INCLUDING MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

Industrial
&
Marine
Coatings

5.12A

COROTHANE® I HS

ALIPHATIC FINISH COAT

B65-50 SERIES

APPLICATION BULLETIN

Revised 4/06

SURFACE PREPARATION

Surface must be clean, dry, and in sound condition. Remove all oil, dust, grease, dirt, loose rust, and other foreign material to ensure adequate adhesion.

Iron & Steel
Remove all oil and grease from surface by Solvent Cleaning per SSPC-SP1. Minimum surface preparation is Commercial Blast Cleaning per SSPC-SP6/NACE 3. For better performance, use Near White Metal Blast Cleaning per SSPC-SP10/ NACE 2. Blast clean all surfaces using a sharp, angular abrasive for optimum surface profile (2 mils). Prime any bare steel the same day as it is cleaned.

Poured Concrete
New
For surface preparation, refer to SSPC-SP13/NACE 6, or ICRI 03732, CSP 1-3. Surface must be clean, dry, sound, and offer sufficient profile to achieve adequate adhesion. Minimum substrate cure is 28 days at 75°F. Remove all form release agents, curing compounds, salts, efflorescence, laitance, and other foreign matter by sandblasting, shotblasting, mechanical scarification, or suitable chemical means. Refer to ASTM D4260. Rinse thoroughly to achieve a final pH between 8.0 and 10.0. Allow to dry thoroughly prior to coating.

Old
Surface preparation is done in much the same manner as new concrete; however, if the concrete is contaminated with oils, grease, chemicals, etc., they must be removed by cleaning with a strong detergent. Refer to ASTM D4258. Form release agents, hardeners, etc. must be removed by sandblasting, shot-blasting, mechanical scarification, or suitable chemical means. If surface deterioration presents an unacceptably rough surface, Kem Cati-Coat HS Epoxy Filler/Sealer is recommended to patch and resurface damaged concrete.
Fill all cracks, voids and bugholes with ArmorSeal Crack Filler.

Always follow the standard methods listed below:
ASTM D4258 Standard Practice for Cleaning Concrete.
ASTM D4259 Standard Practice for Abrading Concrete.
ASTM D4260 Standard Practice for Etching Concrete.
ASTM F1869 Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete.
SSPC-SP 13/Nace 6 Surface Preparation of Concrete
ICRI 03732 Concrete Surface Preparation

Previously Painted Surfaces
If in sound condition, clean the surface of all foreign material. Smooth, hard or glossy coatings and surfaces should be dulled by abrading the surface. Apply a test area, allowing paint to dry one week before testing adhesion. If adhesion is poor, or if this product attacks the previous finish, removal of the previous coating may be necessary. If paint is peeling or badly weathered, clean surface to sound substrate and treat as a new surface as above.

APPLICATION CONDITIONS

Temperature:
air and surface: 20°F minimum, 100°F maximum
material: 45°F minimum
Do not apply over surface ice

Relative humidity: Can be applied at relative humidities up to 99%.

APPLICATION EQUIPMENT

The following is a guide. Changes in pressures and tip sizes may be needed for proper spray characteristics. Always purge spray equipment before use with listed reducer. Any reduction must be compatible with the existing environmental and application conditions.

Reducer/Clean Up
Brush/Roll .... Reducer #15, R7K15
Spray .... Aromatic 100 Reducer, R2K5

Airless Spray
Pump 30:1
Pressure .... 1800 - 2000 psi
Hose .... 1/4" ID
Tip .... .011" - .015"
Filter .... 60 mesh
Reduction .... As needed up to 5% by volume

Conventional Spray

Unit	Graco	Binks
Gun	900	95
Fluid Nozzle	070	66/65
Air Nozzle	947	66PR
Atomization Pressure	60-70 psi	60-70 psi
Fluid Pressure	15-20 psi	15-20 psi
Reduction	As needed up to 5% by volume	

Brush
Brush .... Natural bristle
Reduction .... As needed up to 5% by volume

Roller
Cover .... 1/4" natural or synthetic with phenolic core
Reduction .... As needed up to 5% by volume

If specific application equipment is not listed above, equivalent equipment may be substituted.

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Industrial
&
Marine
Coatings

5.12A

COROTHANE® I HS

ALIPHATIC FINISH COAT

B65-50 SERIES

APPLICATION BULLETIN

APPLICATION PROCEDURES

Surface preparation must be completed as indicated.

Stir paint thoroughly prior to use with a power agitator. Filter slowly through a 55 mesh screen.

Apply paint at the recommended film thickness and spreading rate as indicated below:

Recommended Spreading Rate per coat:

Wet mils:	3.5 - 5.0
Dry mils:	2.0 - 3.0
Coverage:	326 - 489 sq ft/gal approximate

Drying Schedule @ 4.0 mils wet @ 50% RH:

	@ 40°F	@ 77°F	@ 100°F
To touch:	4 hours	2 hours	45 minutes
To recoat:			
minimum:	24 hours	12 hours	6 hours
maximum:	14 days	14 days	14 days
To cure:	7 days	3 days	3 days

If maximum recoat time is exceeded, abrade surface before recoating. Drying time is temperature, humidity, and film thickness dependent.

Application of coating above maximum or below minimum recommended spreading rate may adversely affect coating performance.

PERFORMANCE TIPS

Stripe coat all crevices, welds, and sharp angles to prevent early failure in these areas.

When using spray application, use a 50% overlap with each pass of the gun to avoid holidays, bare areas, and pinholes. If necessary, cross spray at a right angle.

Spreading rates are calculated on volume solids and do not include an application loss factor due to surface profile, roughness or porosity of the surface, skill and technique of the applicator, method of application, various surface irregularities, material lost during mixing, spillage, overthinning, climatic conditions, and excessive film build.

Excessive reduction of material can affect film build, appearance, and adhesion.

In order to avoid blockage of spray equipment, clean equipment before use or before periods of extended downtime with Reducer #15, R7K15.

Pour a small amount of Reducer #15, R7K15 over the top of the paint in the can to prevent skinning or gelling.

Place a temporary cover over the pail to keep excessive moisture, condensation, fog, or rain from contaminating the coating.

Do not exceed recommended dry film thickness.

When applying Corothane I - HS over dark colors, Corothane I Zinc Primers, or porous surfaces, an intermediate coat or a minimum of 2 finish coats is required for adequate hide and uniformity of appearance.

Tinted colors must be used within 7 days after tinting.

E-Z Roll Urethane Defoamer is acceptable for use. See data page 5.99 for details.

Corothane KA Accelerator is acceptable for use. See data page 5.98 for details.

It is recommend that partially used cans not be sealed/closed for use at a later date.

Refer to Product Information sheet for additional performance characteristics and properties.

CLEAN UP INSTRUCTIONS

Clean spills and spatters immediately with Reducer #15, R7K15. Clean tools immediately after use with Reducer #15, R7K15. Follow manufacturer's safety recommendations when using any solvent.

SAFETY PRECAUTIONS

Refer to the MSDS sheet before use.

Published technical data and instructions are subject to change without notice. Contact your Sherwin-Williams representative for additional technical data and instructions.

DISCLAIMER

WARRANTY

THE SHERWIN-WILLIAMS COMPANY

Industrial and Marine Coatings

INDUSTRIAL & MARINE COATINGS

COROTHANE® I MASTIC

B65R13

PRODUCT INFORMATION

Revised 2/03

Product Description

COROTHANE I MASTIC is a single component, moisture curing urethane with micaceous iron oxide, designed as a primer or intermediate coat for previously painted steel surfaces, including lead overcoating. It is high solids and VOC compliant.

- Out performs epoxy mastics when overcoating old red lead coatings
- Low temperature application - down to 20°F
- Can be applied in humidities up to 99%
- Excellent recoatability
- Superior to epoxy mastics for flexibility, corrosion resistance, blister resistance, and impact resistance

Recommended Uses

- As a universal primer or intermediate coat for previously painted surfaces, steel, and weathered galvanized steel
- For application during cold, damp, and/or high humidity conditions limiting the use of conventional coatings

Product Characteristics

Finish: Matte

Color: Reddish Brown

Volume Solids: 60% ± 2%

VOC (calculated): <340 g/L; 2.8 lb/gal

Recommended Spreading Rate per coat:

Wet mils:	4.0 - 5.5
Dry mils:	2.5 - 3.5
Coverage:	275 - 385 sq ft/gal approximate.

Drying Schedule @ 5.0 mils wet @ 50% RH:

	@40°F	@ 77°F	@100°F
To touch:	1 hour	30 minutes	15 minutes
To recoat minimum:	8 hours	4 hours	4 hours
maximum:	60 days	60 days	60 days
To handle:	24 hours	18 hours	5 hours
To cure:	7 days	3 days	3 days

Drying time is temperature, humidity, and film thickness dependent.

Shelf Life: 12 months, unopened, at 77°F

Flash Point: >93°F, PMCC

Reducer/Clean Up: Reducer #15, R7K15

Performance Characteristics

System Tested: (unless otherwise indicated)
Substrate: Steel
Surface Preparation: SSPC-SP6
1 ct. Corothane I MIO-Aluminum @ 3.0 mils dft
1 ct. Corothane I Mastic @ 3.0 mils dft

Abrasion Resistance:
Method: ASTM D4060, CS17 wheel, 1000 cycles, 1 kg load
Result: 17 mg loss

Adhesion:
Method: ASTM D4541
Result: 1000 psi

Corrosion Weathering: (Zinc Primer/Mastic/Aliphatic Finish)
Method: ASTM D5894, 3024 hours, 9 cycles
Result: Rating 10 per ASTM D714 for blistering
Rating 9 per ASTM D610 for rusting

Direct Impact Resistance:
Method: ASTM D2794
Result: 60 in. lbs.

Dry Heat Resistance:
Method: ASTM D2485
Result: 300°F

Flexibility:
Method: ASTM D522, 180° bend, 3/8" mandrel
Result: Passes

Moisture Condensation Resistance:
Method: ASTM D4585, 100°F, 300 hours
Result: Passes

Pencil Hardness:
Method: ASTM D3363
Result: 2B

Salt Fog Resistance: (Zinc Primer/Mastic/Aliphatic Finish)
Method: ASTM B117, 3000 hours
Result: Rating 10 per ASTM D714 for blistering
Rating 9 per ASTM D610 for rusting

Wet Heat Resistance:
Method: Non-immersion
Result: 180°F

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THE SHERWIN-WILLIAMS COMPANY

Industrial and Marine Coatings

INDUSTRIAL & MARINE COATINGS

COROTHANE® I MASTIC

B65R13

PRODUCT INFORMATION

Recommended Systems

Steel:

1 ct.	Corothane I GalvaPac Zinc Primer @ 3.0 - 4.0 mils dft
1 ct.	Corothane I Mastic @ 2.5 - 3.5 mils dft
1 ct.	Corothane I Aliphatic @ 2.0 - 3.0 mils dft
or	Corothane I HS @ 2.0 - 3.0 mils dft

Steel:

1 ct.	Corothane I PrePrime @ 1.5 - 2.0 mils dft
1 ct.	Corothane I MIO-Aluminum @ 2.0 - 3.0 mils dft
1 ct.	Corothane I Mastic @ 2.5 - 3.5 mils dft
1-2 cts.	Corothane I Aliphatic @ 2.0 - 3.0 mils dft/ct

Steel:

1 ct.	Corothane I Mastic @ 2.5 - 3.5 mils dft
1-2 cts.	Corothane I Aliphatic @ 2.0 - 3.0 mils dft/ct

Previously Painted Surfaces:

Spot prime bare steel with 1 coat of Corothane I GalvaPac Zinc Primer

1 ct.	Corothane I Mastic @ 2.5 - 3.5 mils dft
1 ct.	Corothane I Aliphatic @ 2.0 - 3.0 mils dft

The systems listed above are representative of the product's use. Other systems may be appropriate.

Surface Preparation

Surface must be clean, dry, and in sound condition. Remove all oil, dust, grease, dirt, loose rust, and other foreign material to ensure adequate adhesion.

Refer to product Application Bulletin for detailed surface preparation information.

Minimum recommended surface preparation:

Iron & Steel:	SSPC-SP2, SP3
Previously Painted:	SSPC-SP2, SP3

Tinting

Do not tint.

Application Conditions

Temperature:

air and surface:	20°F minimum, 100°F maximum
material:	45°F minimum Do not apply over surface ice
Relative humidity:	Can be applied at relative humidities up to 99%.

Refer to product Application Bulletin for detailed application information.

Ordering Information

Packaging:	1 and 5 gallon containers
Weight per gallon:	18.0 ± 0.2 lb

Safety Precautions

Refer to the MSDS sheet before use.

Published technical data and instructions are subject to change without notice. Contact your Sherwin-Williams representative for additional technical data and instructions.

THE SHERWIN-WILLIAMS COMPANY

INDUSTRIAL & MARINE COATINGS

Industrial and Marine Coatings

5.03A

COROTHANE® I MASTIC

B65R13

APPLICATION BULLETIN

Revised 2/03

Surface Preparation

Surface must be clean, dry, and in sound condition. Remove all oil, dust, grease, dirt, loose rust, and other foreign material to ensure adequate adhesion.

Iron & Steel
Minimum surface preparation is Hand Tool Clean per SSPC-SP2. Remove all oil and grease from surface by Solvent Cleaning per SSPC-SP1. For better performance, use Commercial Blast Cleaning per SSPC-SP6, blast clean all surfaces using a sharp, angular abrasive for optimum surface profile (2 mils). Prime any bare steel within 8 hours or before flash rusting occurs.

Previously Painted Surfaces
If in sound condition, clean the surface of all foreign material. Smooth, hard, or glossy coatings and surfaces should be dulled by abrading the surface. Apply a test area, allowing paint to dry one week before testing adhesion. If adhesion is poor, or if this product attacks the previous finish, removal of the previous coating may be necessary. If paint is peeling or badly weathered, clean surface to sound substrate and treat as a new surface as above.

Application Conditions

Temperature:
- air and surface: 20°F minimum, 100°F maximum
- material: 45°F minimum
  Do not apply over surface ice

Relative humidity: Can be applied at relative humidities up to 99%.

Application Equipment

The following is a guide. Changes in pressures and tip sizes may be needed for proper spray characteristics. Always purge spray equipment before use with listed reducer. Any reduction must be compatible with the existing environmental and application conditions.

Reducer/Clean Up .... Reducer #15, R7K15

Airless Spray
- Pump 30:1
- Pressure .... 1800 - 2000 psi
- Hose .... 1/4" ID
- Tip .... .015" - .019"
- Filter .... 60 mesh
- Reduction .... As needed up to 10% by volume

Conventional Spray

Unit	Graco	Binks
Gun	900	95
Fluid Nozzle	070	66/65
Air Nozzle	947	66PR
Atomization Pressure	60-70 psi	60-70 psi
Fluid Pressure	15-20 psi	15-20 psi
Reduction	As needed up to 10% by volume	

Brush
- Brush .... Natural Bristle
- Reduction .... As needed up to 10% by volume

Roller
- Cover .... 3/8" natural or synthetic with phenolic core
- Reduction .... As needed up to 10% by volume

If specific application equipment is listed above, equivalent equipment may be substituted.

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THE SHERWIN-WILLIAMS COMPANY

COVER THE EARTH

INDUSTRIAL & MARINE COATINGS

Industrial and Marine Coatings

COROTHANE® I MASTIC

B65R13

APPLICATION BULLETIN

APPLICATION PROCEDURES

Surface preparation must be completed as indicated.

Stir paint thoroughly prior to use with a power agitator. Filter slowly through a 55 mesh screen.

Apply paint at the recommended film thickness and spreading rate as indicated below:

Recommended Spreading Rate per coat:

Wet mils:	4.0 - 5.5
Dry mils:	2.5 - 3.5
Coverage:	275 - 385 sq ft/gal approximate.

Drying Schedule @ 5.0 mils wet @ 50% RH:

	@40°F	@ 77°F	@100°F
To touch:	1 hour	30 minutes	15 minutes
To recoat			
minimum:	8 hours	4 hours	4 hours
maximum:	60 days	60 days	60 days
To handle:	24 hours	18 hours	5 hours
To cure:	7 days	3 days	3 days

Drying time is temperature, humidity, and film thickness dependent.

Application of coating above maximum or below minimum recommended spreading rate may adversely affect coating performance.

PERFORMANCE TIPS

Stripe coat all crevices, welds, and sharp angles to prevent early failure in these areas.

When using spray application, use a 50% overlap with each pass of the gun to avoid holidays, bare areas, and pinholes. If necessary, cross spray at a right angle.

Spreading rates are calculated on volume solids and do not include an application loss factor due to surface profile, roughness or porosity of the surface, skill and technique of the applicator, method of application, various surface irregularities, material lost during mixing, spillage, overthinning, climatic conditions, and excessive film build.

Excessive reduction of material can affect film build, appearance, and adhesion.

In order to avoid blockage of spray equipment, clean equipment before use or before periods of extended downtime with Reducer #15, R7K15.

Pour a small amount of Reducer #15, R7K15 over the top of the paint in the can to prevent skinning or gelling.

Place a temporary cover over the pail to keep excessive moisture, condensation, fog, or rain from contaminating the coating.

Corothane KA Accelerator is acceptable for use. See data page 5.98 for details.

It is recommended that partially used cans not be sealed/closed for use at a later date.

Product is designed to be topcoated.

Refer to Product Information sheet for additional performance characteristics and properties.

CLEAN UP INSTRUCTIONS

Clean spills and spatters immediately with Reducer #15, R7K15. Clean tools immediately after use with Reducer #15, R7K15. Follow manufacturer's safety recommendations when using any solvent.

SAFETY PRECAUTIONS

Refer to the MSDS sheet before use.

Published technical data and instructions are subject to change without notice. Contact your Sherwin-Williams representative for additional technical data and instructions.

PRODUCT PROFILE

GENERIC DESCRIPTION	Modified Polyamidoamine Epoxy
COMMON USAGE	High-build coating with superior wetting for marginally prepared rusty steel and tightly adhering old coatings. Excellent abrasion-, chemical- and corrosion-resistance. Perfect foundation for aliphatic-polyurethanes. NOT FOR IMMERSION SERVICE.
COLORS	DC74 Off-White, 1243 Metallic Aluminum and more; refer to Tnemec Color Guide. **Note:** Epoxies chalk with extended exposure to sunlight. Lack of ventilation, incomplete mixing, miscatalyzation or the use of heaters that emit carbon dioxide and carbon monoxide during application and initial stages of curing may cause yellowing to occur.
FINISH	Semi-gloss
PERFORMANCE CRITERIA	Extensive test data available. Contact your Tnemec representative for specific test results.

COATING SYSTEM

PRIMERS	**Steel:** Self-priming **Galvanized Steel and Non-Ferrous Metal:** Self-priming
TOPCOATS	Series 28, 29, 30, 66, N69, 73, 84, 104, 135, 161, 175, 1074, 1075. **Note:** When topcoating with Endura-Shield polyurethane finish, exterior exposed Series 135 has the following maximum time to recoat: Series 73, 175, 1074 or 1075, 60 days. If this time is exceeded, an epoxy intermediate coat or scarification is required before topcoating. Refer to appropriate topcoat data sheet for additional information.

SURFACE PREPARATION

STEEL	Abrasive blast cleaning generally produces the best coating performance. If conditions will not permit this, Series 135 may be applied to SSPC-SP2 or SP3 Hand or Power Tool Cleaned surfaces.
GALVANIZED STEEL & NON-FERROUS METAL	Surface preparation recommendations will vary depending on substrate and exposure conditions. Contact your Tnemec representative or Tnemec Technical Services.
PAINTED SURFACES	Test patch is recommended.
ALL SURFACES	Must be clean, dry and free of oil, grease and other contaminants.

TECHNICAL DATA

VOLUME SOLIDS* — 84.0 ± 2.0% (mixed)

RECOMMENDED DFT — **Conventional Build:** 4.0 to 6.0 mils (100 to 150 microns) per coat.
Hi-Build: 7.0 to 9.0 mils (180 to 230 microns) per coat.
Note: Number of coats and thickness requirements will vary with substrate, application method and exposure. Contact your Tnemec representative.

CURING TIME

Temperature	To Touch	To Handle	To Recoat
75°F (24°C)	6 hours at 5.0 mils DFT (125 microns)	18 hours	24 hours

Curing time varies with surface temperature, air movement, humidity and film thickness.

VOLATILE ORGANIC COMPOUNDS*

Unthinned	Thinned 15% (No. 19 Thinner)	Thinned 15% (No. 18 Thinner)
1.16 lbs/gallon (139 grams/litre)	1.92 lbs/gallon (230 grams/litre)	2.06 lbs/gallon (247 grams/litre)

THEORETICAL COVERAGE*	1,347 mil sq ft/gal (33.1 m^2/L at 25 microns). See APPLICATION for coverage rates.	
NUMBER OF COMPONENTS	Two: Part A and Part B	
PACKAGING	Five-Gallon Kit: Consists of four gallons of Part A in a five-gallon pail and one gallon of Part B in a one-gallon can. When mixed, yields five gallons (18.9L). One-Gallon Kit: Consists of a partially filled one-gallon can of Part A and a partially filled one-quart can of Part B. When mixed, yields one gallon (3.79L).	
NET WEIGHT PER GALLON*	Series 135: 12.30 ± 0.25 lbs (5.58 ± .11 kg) (mixed) 135-1243: 11.52 ± 0.25 lbs (5.23 ± .11 kg) (mixed)	
STORAGE TEMPERATURE	Minimum 20°F (-7°C)	Maximum 120°F (49°C)
TEMPERATURE RESISTANCE	(Dry) Continuous 250°F (121°C)	Intermittent 275°F (135°C)
SHELF LIFE	24 months at recommended storage temperature.	
FLASH POINT - SETA	Part A: 75°F (25°C)	Part B: 201°F (94°C)

TECHNICAL DATA continued

HEALTH & SAFETY

Paint products contain chemical ingredients which are considered hazardous. Read container label warning and Material Safety Data Sheet for important health and safety information prior to the use of this product. **Keep out of the reach of children.**

APPLICATION

COVERAGE RATES*

	Conventional Build (Spray, Brush or Roller)			Hi-Build (Spray Only)		
	Dry Mils (Microns)	**Wet Mils (Microns)**	**Sq Ft/Gal (m^2/Gal)**	**Dry Mils (Microns)**	**Wet Mils (Microns)**	**Sq Ft/Gal (m^2/Gal)**
Suggested	5.0 (125)	6.0 (150)	269 (25.0)	8.0 (205)	9.5 (240)	168 (15.6)
Minimum	4.0 (100)	5.0 (125)	337 (31.3)	7.0 (180)	8.5 (215)	192 (17.8)
Maximum	6.0 (150)	7.0 (180)	224 (20.8)	9.0 (230)	11.0 (280)	150 (13.9)

Note: Can be spray applied at 7.0 to 9.0 mils (180 to 230 microns) DFT per coat when extra protection or the elimination of a coat is desired. Can be sprayed at 4.0 to 6.0 mils (100 to 150 microns) DFT per coat for use in systems requiring a conventional build. Brush or roller will normally achieve the 4.0 mil (100 microns) minimum for conventional build application. However, under certain conditions some colors may require two coats to achieve suggested film thickness. Allow for overspray and surface irregularities. Film thickness is rounded to the nearest 0.5 mil or 5 microns. Application of coating below minimum or above maximum recommended dry film thicknesses may adversely affect coating performance.

MIXING

Power mix contents of each container, making sure no pigment remains on the bottom. Add the contents of the can marked Part B to Part A while under agitation. Continue agitation until the two components are thoroughly mixed. Do not use mixed material beyond pot life limits. **Note:** Both components must be above 50°F (10°C) prior to mixing. For application to surfaces between 50°F to 60°F (10°C to 16°C), allow mixed material to stand thirty (30) minutes and restir before using. For optimum application properties, blended components should be above 60°F (16°C).

POT LIFE

8 hours at 50°F (10°C) 4 hours at 77°F (25°C) 2 hours at 100°F (38°C)

THINNING

For air or airless spray, thin 10% to 15% or ¾ pint to 1¼ pints (380 to 570 mL) per gallon with No. 19 Thinner. For brush or roller, thin 10% to 15% or ¾ pint to 1¼ pints (380 to 570 mL) per gallon with No. 18 Thinner.

SURFACE TEMPERATURE

Minimum 50°F (10°C) Maximum 135°F (57°C)

The surface should be dry and at least 5°F (3°C) above the dew point. **Note:** Amine blush may develop during cure if the surface temperature drops below the minimum, particularly under high humidity. Blush must be removed prior to topcoating; contact your Tnemec representative.

APPLICATION EQUIPMENT

Air Spray

Gun	Fluid Tip	Air Cap	Air Hose ID	Mat'l Hose ID	Atomizing Pressure	Pot Pressure
DeVilbiss MBC or JGA	E	765 or 78	5/16" or 3/8" (7.9 or 9.5 mm)	3/8" or 1/2" (9.5 or 12.7 mm)	70-90 psi (4.8-6.2 bar)	20-30 psi (1.4-2.1 bar)

Low temperatures or longer hoses require higher pot pressure.

Airless Spray

Tip Orifice	Atomizing Pressure	Mat'l Hose ID	Manifold Filter
0.015"-0.021" (380-535 microns)	2800-4200 psi (193-290 bar)	1/4" or 3/8" (6.4 or 9.5 mm)	60 mesh (250 microns)

Use appropriate tip/atomizing pressure for equipment, applicator technique and weather conditions.
Note: Series 135-1243 must be applied by brush or roller to achieve aluminum appearance. For spray application, contact your Tnemec representative.
Roller: Use 3/8" or 1/2" (9.5 mm or 12.7 mm) synthetic nap covers.
Brush: Use high quality natural or synthetic bristle brushes.

CLEANUP

Flush and clean all equipment immediately after use with the recommended thinner or MEK.

*Values may vary with color.

PRODUCT PROFILE

GENERIC DESCRIPTION: Fluoropolymer Polyurethane

COMMON USAGE: An exterior finish coat especially designed for tanks and other exposed steel substrates. HydroFlon has outstanding resistance to ultra-violet light degradation providing unprecedented long-term gloss and color retention with excellent resistance to abrasion and chalking. It is aesthetically pleasing and recommended for coastal environments and on structures where extremely long-term maintenance cycles are desired. NOT FOR IMMERSION SERVICE.

COLORS: Refer to Tnemec Color Guide. **Note:** Certain colors may require multiple coats depending on method of application and finish coat color. The preceding coat should be in the same color family, but noticeably different. Upon selection of the finish coat color (Series 701), the intermediate coat color will be selected by Tnemec's color lab.

FINISH: Semi-gloss

PERFORMANCE CRITERIA: Contact your Tnemec representative for specific test results.

COATING SYSTEM

PRIMERS: Series 20, FC20, 27, 66, N69, 90-97, 91-H_20, 135, N140, 161, 594

INTERMEDIATE: Series 73, 1075

Note: Recoat windows apply when topcoating Series 701 with itself. Contact Tnemec Technical Service for details.

SURFACE PREPARATION

EXTERIOR EXPOSURE: SSPC-SP6 Commercial Blast Cleaning

ALL SURFACES: Must be clean, dry and free of oil, grease and other contaminants.

TECHNICAL DATA

VOLUME SOLIDS*: 62.0 ± 2.0% (mixed)

RECOMMENDED DFT: 2.0 to 3.0 mils (50 to 75 microns) per coat. **Note: Number of coats and thickness requirements will vary with substrate, application method and exposure. Contact your Tnemec representative.**

CURING TIME:

Temperature	To Touch	To Handle	To Recoat
75°F (24°C)	1½ hours	6-8 hours	24 hours

Curing time varies with surface temperature, air movement, humidity and film thickness. **Note:** For faster curing and low-temperature applications, add No. 44-710 Urethane Accelerator; see separate product data sheet.

VOLATILE ORGANIC COMPOUNDS*:

Unthinned	Thinned 5% (No. 39 Thinner)	Thinned 5% (No. 56 Thinner)
2.65 lbs/gallon (317 grams/litre)	3.09 lbs/gallon (370 grams/litre)	2.67 lbs/gallon (320 grams/litre)

THEORETICAL COVERAGE*: 987 mil sq ft/gal (24.2 m^2/L at 25 microns).

NUMBER OF COMPONENTS: Two: Part A and Part B

MIXING RATIO: By volume: Five (Part A) to one (Part B)

PACKAGING: One-Gallon Kit: Consists of a partially-filled one gallon can labeled Part A and a partially filled quart can labeled Part B. When mixed, yields one gallon (3.79L).

Three-Gallon Kit: Consists of a three-gallon pail containing 2.5 gallons of Part A and a full half-gallon pail of Part B. When mixed, yields three gallons (11.35L).

NET WEIGHT PER GALLON*: 11.48 ± 0.25 lbs (5.21 ± .11 kg) (mixed)

STORAGE TEMPERATURE: Minimum 20°F (-7°C) Maximum 110°F (43°C)

TEMPERATURE RESISTANCE: (Dry) Continuous 250°F (121°C) Intermittent 275°F (135°C)

SHELF LIFE: 12 months at recommended storage temperature.

FLASH POINT - SETA: Part A: 81°F (27°C) Part B: 130°F (54°C)

HEALTH & SAFETY: Paint products contain chemical ingredients which are considered hazardous. Read container label warning and Material Safety Data Sheet for important health and safety information prior to the use of this product. **Keep out of the reach of children.**

APPLICATION

COVERAGE RATES*

	Dry Mils (Microns)	Wet Mils (Microns)	Sq Ft/Gal (m^2/Gal)
Suggested	2.5 (65)	4.0 (100)	398 (37.0)
Minimum	2.0 (50)	3.0 (75)	497 (46.2)
Maximum	3.0 (75)	5.0 (125)	331 (30.8)

Allow for overspray and surface irregularities. Wet film thickness is rounded to the nearest 0.5 mil or 5 microns. **Application of coating below minimum or above maximum recommended dry film thicknesses may adversely affect coating performance.**

MIXING Stir contents of the container marked Part A, making sure no pigment remains on the bottom. Add the contents of the can marked Part B to Part A while under agitation. Continue agitation until the two components are thoroughly mixed. Do not use mixed material beyond pot life limits. **Caution:** Part B is moisture-sensitive and will react with atmospheric moisture. Keep unused material tightly closed at all times.

POT LIFE 5 hours at 50°F (10°C) 2 hours at 70°F (21°C) 1 hour at 90°F (32°C)

THINNING For air spray, thin up to 5% or ¼ pint (190 mL) per gallon with No. 39 Thinner. For roller, thin 3% to 5% or ¼ pint (190 mL) per gallon with No. 39 Thinner. Thinning is required for proper application. **Caution:** Do not add thinner if more than thirty (30) minutes have elapsed after mixing. **Note:** Where lower VOC is required, a maximum of 5% of No. 56 Thinner may be used to comply with VOC regulations.

SURFACE TEMPERATURE Minimum 40°F (4°C) Maximum 120°F (49°C)

The surface should be dry and at least 5°F (3°C) above the dew point.

Cure time necessary to resist direct contact with moisture at surface temperature:

40°F (4°C): 44 hours 50°F (10°C): 21½ hours 60°F (16°C): 11 hours

70°F (21°C): 7 hours 80°F (27°C): 5 hours 90°F (32°C): 3½ hours

100°F (38°C): 2 hours

If the coating is exposed to moisture before the preceding cure parameters are met, dull, flat or spotty-appearing areas may develop. Actual times will vary with air movement, film thickness and humidity.

APPLICATION EQUIPMENT

Air Spray

Gun	Fluid Tip	Air Cap	Air Hose ID	Mat'l Hose ID	Atomizing Pressure	Pot Pressure
DeVilbiss JGA	E	765 or 704	5/16" or 3/8" (7.9 or 9.5 mm)	3/8" or 1/2" (9.5 or 12.7 mm)	75-90 psi (5.2-6.2 bar)	10-20 psi (0.7-1.4 bar)

Low temperatures or longer hoses require higher pot pressure.

Use appropriate tip/atomizing pressure for equipment, applicator technique and weather conditions.

Roller: Use 1/4" (6.4 mm) synthetic nap cover. Do not use medium or long nap roller covers.

Brush: Recommended for small areas only. Use high quality natural or synthetic bristle brushes.

CLEANUP Flush and clean all equipment immediately after use with the recommended thinner or MEK.

*Values may vary with color.

Appendix F: Overcoating Inspection Report

MARK 10 Resource Group, Inc.
11641 Drysdale Drive, Richmond, VA 23236 (804) 379-2676 FAX (804) 379-2521

June 2, 2006

Mr. Charlie Gibbs
S&K Technologies, Inc.
309 Osigian Blvd.
Warner Robins, GA 31088

RE: Order Number 5014-MARK-001 (Final Inspection Report)

Mr. Gibbs,

The following constitutes the Final Inspection Report for the on-site inspection MARK 10 Resource Group, Inc. conducted at Ft. Campbell, KY (AR-F-320 – Surface Tolerant Coatings for Aircraft Hangars, Flight Control Towers).

BACKGROUND INFORMATION & GENERAL COMMENTS:

From October 24 - 26, 2005, MARK 10 Resource Group, Inc. (hereafter referred to as MARK 10) conducted an on-site final inspection of the work performed by MANTA Industrial Inc., (hereafter referred to as MANTA), at Ft. Campbell, KY. MANTA's tasks included surface preparation and overcoating five structures located at Ft. Campbell with two coats of paint. Reportedly some of the structures contain lead base paint.

The structures inspected and their building number designations are as follows:

- Hangar #1 – Building 7161
- Hangar #2 – Building 7156
- Flight Control Tower – Building 7212
- Sabre Deluge Tank – Building 6623A
- Destiny Deluge Tank – Building A7219

With the exception of the Flight Control Tower, MANTA reportedly coated all of the structures with a moisture-cured polyurethane primer coat (Sherwin Williams Corothane I Mastic) and a moisture-cured polyurethane finish coat (Sherwin Williams Corothane I Ironox A). MANTA coated the Flight Control Tower with a different system consisting of an epoxy primer (Tnemec Series 135 Chembuild) and a fluoropolymer finish coat (Tnemec Series 701 Hydroflon).

From September 28 – 30, 2006, MARK 10 conducted an in-progress inspection of the work MANTA had performed up to that time. A report detailing the findings of that inspection was written previously. The primary non-conformance issues raised in the In-Progress Inspection Report involved the following items:

- Removal of remaining loose paint (especially but not exclusively on Hangar #1) in accordance with the definition of SSPC SP 2 and / or SSPC SP 3
- Touch-up areas where visible holidays or misses exist in the Sherwin Williams Corothane I Mastic primer
- Removal of preexisting coatings that curled or lifted after the application of the Sherwin Williams Corothane I Mastic primer
- Removal of runs that were not preexistent
- Removal of embedded foreign debris that are lodged within the Sherwin Williams Corothane I Mastic primer
- Rewashing the Destiny Deluge Tank to remove the chalk that formed on the outer layer of the Sherwin Williams Corothane I Mastic primer

During the final inspection, the verifiable items listed above were checked for compliance. Discrepancies in any of these items or in additional items that were observed during the final inspection were corrected by MANTA during the final inspection.

The remedial work on some of the items observed during the previous in-progress inspection took place after the in-progress inspection and before the final inspection, when MARK 10 was not on-site; therefore, MARK 10 cannot verify that these items were performed. For example, MARK 10 was not on-site when MANTA performed the following tasks:

- Touch-up areas where visible holidays or misses existed in the Sherwin Williams Corothane I Mastic primer
- Removal of runs that were not preexistent
- Rewashing the Destiny Deluge Tank to remove the chalk that formed on the outer layer of the Sherwin Williams Corothane I Mastic primer

This Final Inspection Report identifies various issues observed by MARK 10 during the final inspection on a structure-by-structure basis. Some of these issues required remedial action and others did not require corrective measures. MANTA's crew corrected the identified items requiring action while the inspection was underway.

Some of the issues presented in this report did not require remedial action, since the project requirements did not address them; however, in order to provide documentation for future reference, any item observed that could develop into a potential future problem was identified and photographs were provided if they were available.

In addition to visual inspection, MARK 10 measured the average dry film thickness (dft) for all of the structures MANTA painted. The average dft measurement for each building obtained during the in-progress inspection was subtracted from the final inspection average dft value in order to determine the average finish coat dft for each structure. A summary table displaying the average dft values obtained for each structure is shown in Table 1.

For the four structures to which MANTA applied the moisture-cured polyurethane system the manufacturer's recommended dry film thickness range for the finish coat is 2.5 to 3.5

mils. Based on this value, the average topcoat dft on the Destiny Deluge Tank is slightly low (2.36 mils). The average topcoat dft on the Sabre Deluge tank is at the upper recommended limit (3.5 mils). The average topcoat dry film thickness for Hangar #1 (4.45 mils) and for Hangar #2 (5.34) are both high and exceed the manufacturer's upper limit. The finish coat dry film thickness in some areas on Hangar #2 is extremely high. This could result in localized delamination in the future as the coating reacts to thermal contraction and expansion of the substrate. Additional stress will also be placed upon the underlying coatings in these areas, possibly causing delamination if their bond to the underlying galvanized substrate is weak or marginal.

For the Flight Control Tower (FCT), MANTA applied a different two-coat paint system manufactured by the Tnemec Company. The manufacturer's recommended total dft for the two-coat system applied on the FCT is 5.0 – 7.0 mils. The average dft measurement for the FCT was 4.31 mils. This value includes both coats. It is slightly below the 5.0 mil minimum recommended dft, however at the time of the in-progress inspection, the FCT was covered with chalky paint and MANTA had not cleaned or primed it. An attempt was made during the in-progress inspection to remove some of the chalk with a dry cloth before taking dft measurements; however, this method is not as effective as the 5,000 psi pressure washing used by MANTA to clean the structure at a later date.

The in-progress inspection average on the FCT of 1.59 mils dft overstated the actual dft, since the Flight Control Tower contained significant chalk when its precleaned dft was measured. It is reasonable to estimate that the chalk on the building during the in-progress readings accounted for approximately 0.25 to 0.50 mils dft. Subtracting 0.50 mils from the 1.59 mil average provides a modified in-progress inspection average of 1.09 mils dft. Subtracting this value from the 5.9 mil final inspection average dft yields an average two-coat dft of 4.81 mils.

Table 1: Average Topcoat Dry Film Thickness (DFT) on Each Structure (in mils)

STRUCTURE	Destiny Deluge Tank	Sabre Deluge Tank	Hangar #1	Hangar #2	Flight Control Tower
Final Inspection Average DFT	7.17	8.69	9.83	14.82	5.9
In-Progress Inspection Average DFT	4.81	5.19	5.38	9.48	1.59
Average Topcoat DFT	**2.36**	**3.5**	**4.45**	**5.34**	**4.31***
Recommended topcoat DFT listed on Manufacturers Product Data Sheet	2.5 – 3.5	2.5 – 3.5	2.5 – 3.5	2.5 – 3.5	2.0 – 3.0
Comments	Slightly Low	Complies	High	High	Slightly Low*
*Note: DFT for the Flight Control Tower includes Tnemec Series 135 Chembuild primer dft and Tnemec Series 701 Hydroflon topcoat dft since the in-progress dft readings occurred prior to MANTA applying the primer on this structure.					

The dry film thickness measurements for each structure are provided in three manners within this report. First, a summary table indicating the average dft for each individual structure is shown in Table 1. Second, the averages for each five spot measurements taken in each area of the particular structure are provided in the section addressing that structure.

Third, the individual gage readings are presented in an elongated table at the end of the section for each structure.

GENERAL COMMENTS:

Manta Industrial, Inc.'s TASK Order for this project served as the basis for MARK 10 conducting this final inspection and determining whether the contractor's work complied with the contractual requirements. ERDC/CERL provided MARK 10 Resource Group, Inc. with the following documents related to this project:

1. Task Order 5014-MANT-001 issued by S&K Technologies to Manta Industrial Inc. (Contractor's Proposal, Terms & Conditions, and Statement of Work)
2. Overcoating of Lead-Based Paint on Steel Structures (ERDC/CERL TR-03-5)

As mentioned in the previous in-progress inspection report, one general discrepancy was noted between the Contractor's Proposal, the Statement of Work and the contractor's actual work. This discrepancy concerns the contractor's surface preparation method. In Task One of the Contractor's Statement of Work, the surface preparation method, Power Tool Cleaning (SSPC SP 3) and a specific type and brand of power tool (3M Brand Clean and Strip Pads) were required.

MANTA reportedly did not use the specific tools required in the Statement of Work and in the specifications. MANTA did not prepare the surface using Power Tools equipped with rotary cleaning tools with 3M Brand Clean and Strip Pads. Their primary surface preparation method consisted of low-pressure water washing the surfaces, reportedly followed by some Hand Tool Cleaning (SSPC SP 2).

According to Task One of MANTA's Statement of Work, the surface preparation requirements included the following:

- Prepare all the steel structures listed in Table 1 for overcoating by scrapping off loose paint and rinsing with water in accordance with SSPC SP 3 Power Tool Cleaning using two rotary cleaning tools equipped with 3M Brand Clean and Strip Pads.

In their proposal dated 02-14/05, Manta Industrial Inc., proposed preparing the surface as follows:

- Low-pressure wash surfaces to be recoated per specifications "Overcoating of Lead Based Paint on Steel Structures".
- SSPC-SP 3 Power Tool Clean loose paint or rust.
- SSPC-SP 1 Solvent wipe as necessary

MANTA's proposal makes no mention of using rotary cleaning tools equipped with 3M Brand Clean & Strip Pads, although MANTA does state they plan to perform SSPC SP 3 Power Tool Cleaning. Based on interviews conducted with MANTA's on-site personnel

and an inspection of surfaces, MANTA did not prepare the surface using power tools (SSPC SP 3). Instead MANTA employed a low-pressure water wash, reportedly followed by a Hand Tool Cleaning (SSPC SP 2) when necessary.

By definition, surfaces prepared in accordance with SSPC SP 2 and SSPC SP 3 require the removal of *"all loose mill scale, loose rust, loose paint, and other loose detrimental foreign matter. Mill scale, rust and paint are considered adherent if they cannot be removed by lifting with a dull putty knife."*

During the final inspection, several issues requiring corrective action prior to completing the project were identified and discussed with MANTA's onsite supervisor, Mr. Rick Traughber. These issues included the following:

- Removal and repair of remaining loose paint on a few of the structures in accordance with the definition of SSPC SP 2 and SSPC SP 3
- Removal and repair of preexisting coatings that curled or lifted after the application of the coating system
- Repair of one area of on the Destiny Deluge, two areas on the Flight Control Tower, and one area on Hangar #2 where the coating was damaged or delaminating

Several areas were observed where feathering the edges of areas where some of the coatings were removed by pressure washing or hand tool cleaning would have been beneficial. However, the contractor's scope of work did not require feathering back the edges of the coatings in areas where some or all of the previously applied coatings were removed as a result of the surface preparation operations. Examples of unfeathered areas are shown in this final inspection report to provide documentation in the event that premature failures occur in these areas.

After the in-progress inspection, MANTA performed extensive remedial work on Hangar #1 to remove the loose and curled coatings. These areas were reexamined during the final inspection. MANTA's remedial work on these areas on Hangar #1 was outstanding.

The information provided in this report is based on MARK 10's limited accessibility to the structures as follows:

- For Hangar # 1 and # 2, direct access was limited to the lower 6 to 8 feet of the structures, with the exception that on Hangar #2 accessibility also included one area along the side of the building where an exterior staircase facilitated inspection of the siding up to the second floor level.

- For the Flight Control Tower, direct access was limited to the lower 6 to 8 feet of the structure and to the walkway around the top of the structure.

- For the Destiny and Sabre Deluge Tanks, direct access was limited to the lower 6 to 8 feet around the tank's circumference, to areas adjacent to the permanently installed ladder and to the roof area.

DESTINY DELUGE TANK – BUILDING A7219

Figure 1: Destiny Deluge Tank

GENERAL CONDITION: The exterior of the Destiny Deluge Tank consists of approximately 6,287 square feet. It is constructed of steel and was previously painted. MANTA applied the Sherwin Williams Corothane I Mastic primer and the Sherwin Williams Corothane I Ironox A topcoat to this structure.

MARK 10 performed a visual inspection of the Destiny Deluge Tank and measured the coating dry film thickness. MANTA corrected the visual deficiencies that were identified and that were required by the Statement of Work.

In regards to the Destiny Deluge Tank, the following general observations were made:

- In a few areas the previously applied coating was not tightly adhered, in accordance with the requirements of SSPC SP 2 and SSPC SP 3
- In one area, the new coatings delaminated from a previous coat and chalk was present on the surface of the underlying coating
- Several areas with unfeathered coatings were observed
- Minor lifting and or curling of previously applied coatings in a few areas
- Small pieces of roller nap were embedded within the finish coat in some areas

COMMENTS: Each of the issues listed above was presented to MANTA's on-site supervisor and appropriate corrective measures were discussed and agreed upon.

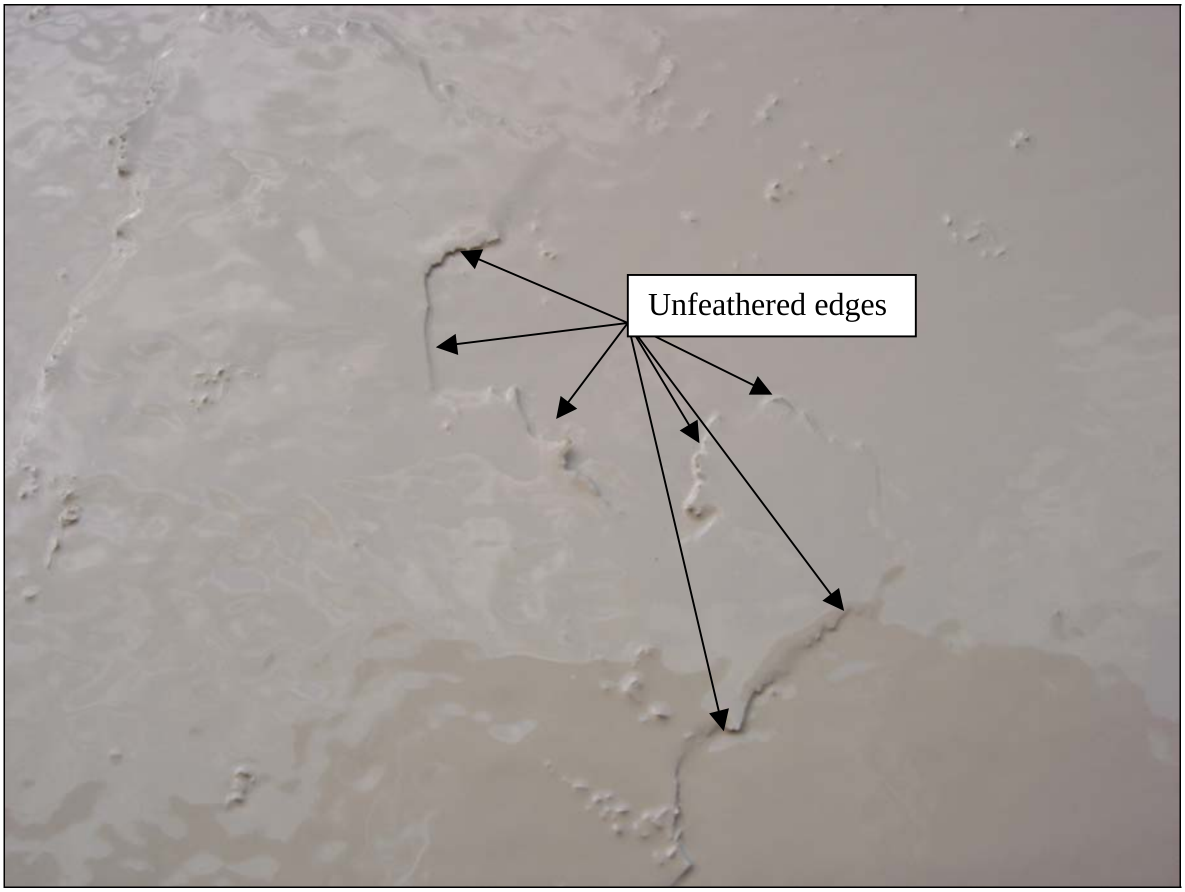

Figure 2: Unfeathered areas on Destiny Tank

MANTA's Statement of Work did not require feathering; however, some of these unfeathered areas are already showing initial indications of lifting. Coatings tend to pull away from these jagged edges during the curing process, leaving them exposed. Over time as the tank surface is exposed to thermal gradients, it will contract and expand. It is likely that additional degradation and / or lifting will occur in some of these unfeathered areas over time. It is advisable to inspect these areas on a periodic basis so that minor repairs can be affected if necessary.

In a few areas on the Destiny Tank, the previously applied coating was not tightly adhered, in accordance with the requirements of SSPC SP 2 and SSPC SP 3. In some cases the coating was noticeably lifted off the surface. A dull putty knife was used in these areas and the coating was easily removed. It is possible that some of the lifting is due to curling resulting from exposing a previously applied coating that is sensitive to the solvents in either the Sherwin Williams Corothane I Mastic or the Corothane Ironox A.

If the lifting is a result of curling, it will occur in the areas where the solvent sensitive coating is exposed to the solvents in the new coatings. Feathering would not eliminate the problem if curling or lifting resulted from the exposure of a previously applied, solvent sensitive coating to an incompatible solvent. In fact, feathering would increase the problem. Since most of the edges are not indicating a problem with lifting, it appears at this time that the problem likely occurred as a result of the specification not requiring feathering these areas to provide a smooth and gradual transition for the application of subsequent coats.

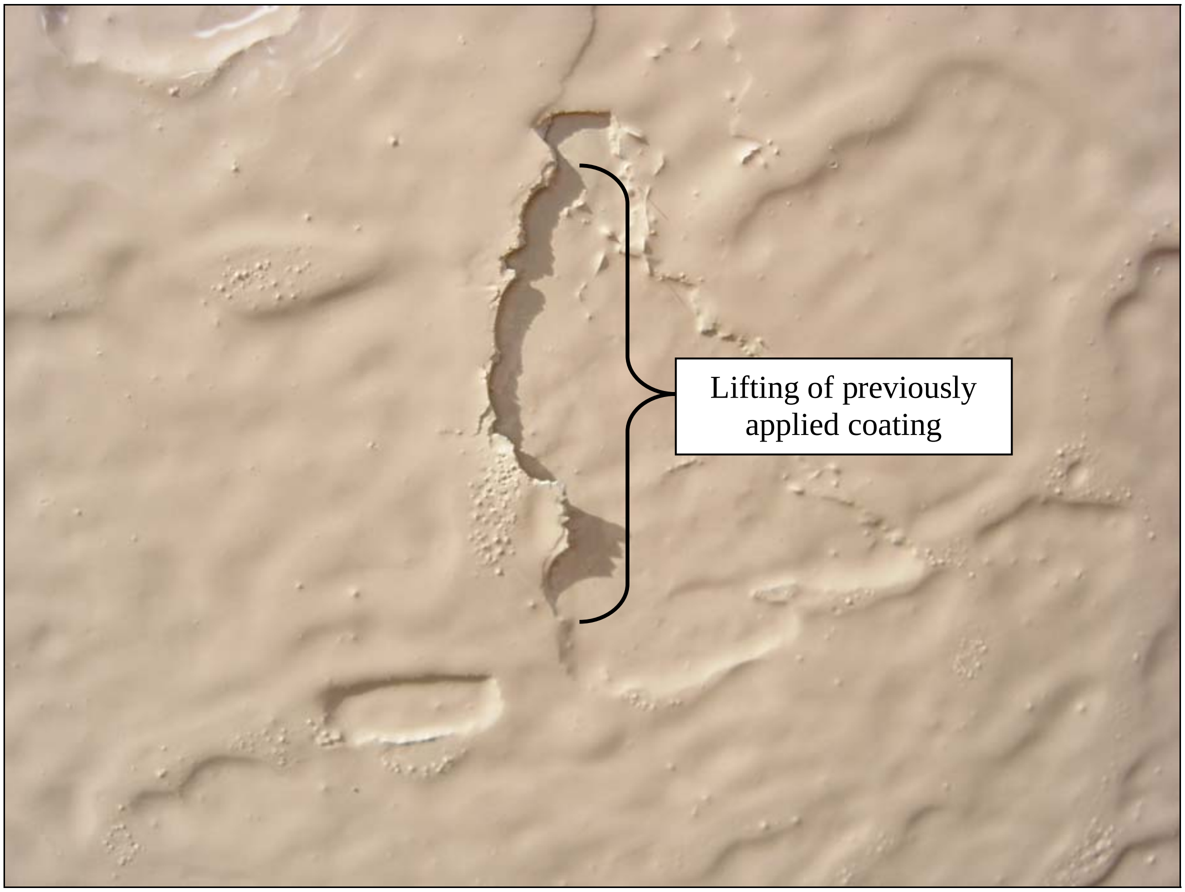

Figure 3: Lifting of the previously applied coating along the unfeathered edge

MANTA repaired the area shown in Figure 3 before the conclusion of the final inspection.

Figure 4 shows several examples of coatings that are not tightly adhered and that were easily removed when subjected to a dull putty knife. The adjoining areas were tightly adhered and were not removed when subjected to a dull putty knife. Normally the surface is subjected to the dull putty knife after it is prepared and before additional coatings are applied; however, in this case, full time inspection was not a part of the scope of work and MARK 10 was not on site to check these areas after MANTA's surface preparation and or repair work was performed on these areas. For this reason the putty knife was used in areas where visible evidence of loose coatings appeared to exist.

The area shown in Figure 4 (before being subject to the dull putty knife) is shown in Figure 5, after it was subject to the dull putty knife. The putty knife removed at least two and possibly three layers of coating in this area and exposed a previously applied coating.

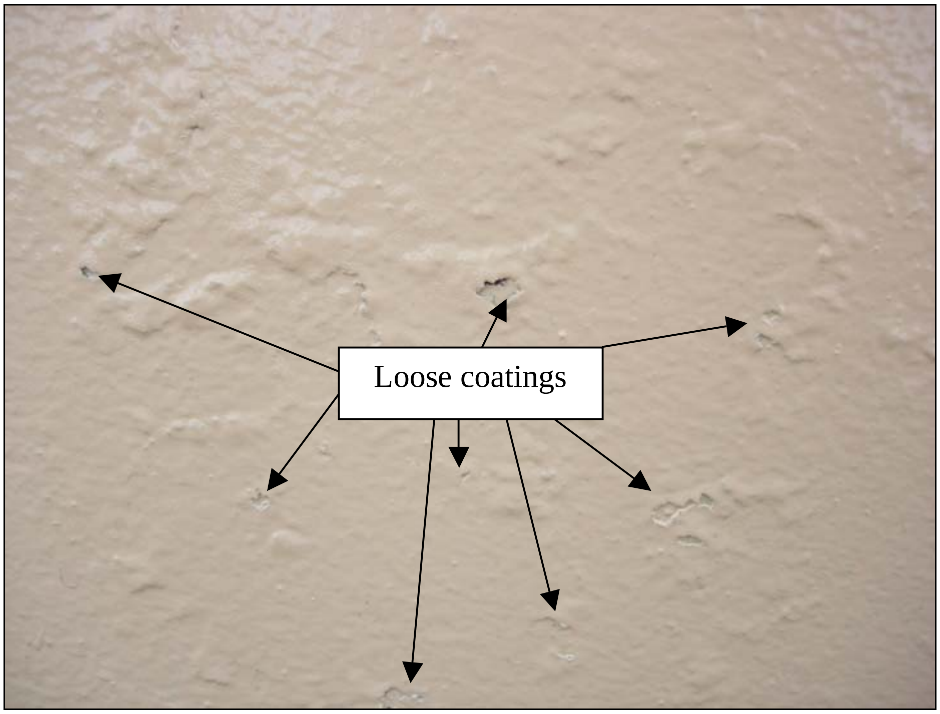

Figure 4: Loose coatings prior to dull putty knife test

Figure 5: Loose coatings removed with dull putty knife

Figure 6: Long view of delaminating paint

The area shown in Figure 5 was repaired by MANTA prior to the completion of the final inspection.

On the Destiny Tank, one area was observed with loose paint that was delaminating. Upon closer examination it was determined that chalk on a previous coating was not removed before a subsequent coat was applied. The dark red color of the coating from which the delamination occurred (see Figure 7) does not appear to match the Corothane I Mastic primer, therefore it was determined that it was likely a coating applied previous to MANTA's work.

However, it is noteworthy that during the in-progress inspection, the outer surface of the Corothane I Mastic primer that MANTA applied was chalky. Reportedly this coat was applied only two weeks previous to the inspection. MANTA agreed to clean off the chalk before applying the topcoat. Based on examining the back of the delaminated coating, it appears that the back of the chip contains all or part of the Corothane I Mastic primer and possible another previous coat.

Figure 7: Close up of area shown in Figure 6

Figure 8 shows red chalky paint on the end of the report author's fingers after they were rubbed across the surface at the top of the picture. Three track marks from where the fingers were moved across the red surface are visible. Chalk is essential dead paint caused by ultraviolet degradation of the binder and or pigments. If coatings are applied on top of a chalky surface, their adhesion will be marginal at best. (Note: The area shown in Figure 8 was cleaned and repaired by MANTA.)

Figure 8: Chalk seen on fingers after rubbing on coated surface where delamination occurred

Figure 9: Backside of coating that delaminated

On portions of the tank areas with small pieces of embedded roller nap are visible within the finish coat. MANTA took appropriate measures to prevent this from occurring. They used non-shedding roller covers; however, the roller nap unfortunately shed and it was embedded within the film.

In regards to these small pieces of embedded roller nap, (see Figure 10), it would be necessary to remove the topcoat in these area to effectively remove the roller nap entirely. As this would likely cause damage to previous coats, MANTA did not remove the embedded roller nap from within the finish coat on the Destiny Deluge Tank.

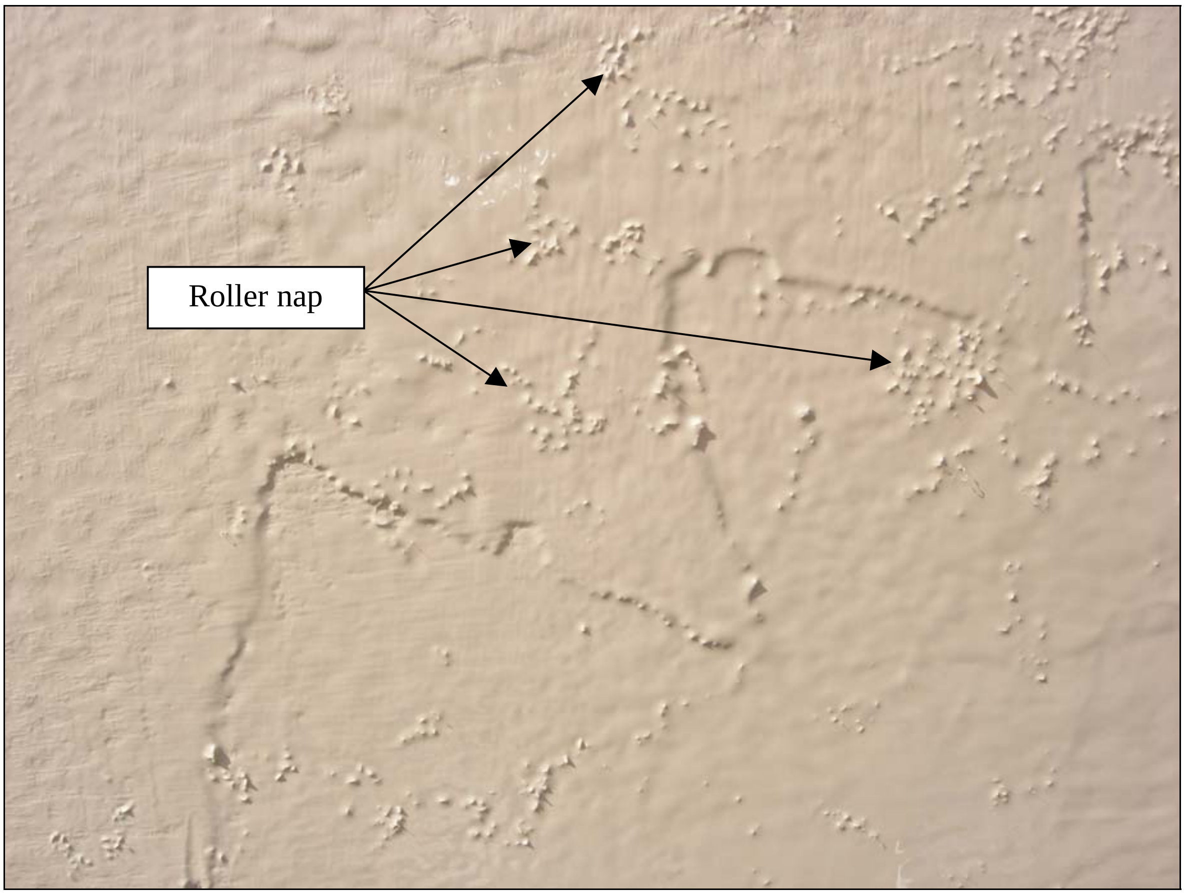

Figure 10: Small pieces of roller nap embedded within the Corothane I Ironox A finish coat

DRY FILM THICKNESS MEASUREMENTS:

MARK 10 measured the dry film thickness on the Destiny Deluge Tank using a Positector 6000 FN3 gage. The dft figures provided in Table 2 represent the average of each of the five spot measurements taken on 20 different areas of the tank. Since each spot measurement consists of at least three individual gage readings, and five spot measurements are taken in each area measured, a total of 300 individual gage readings

were taken. The average dft for these measurements was 7.17 mils. This figure includes the two coats applied by MANTA and the previously applied coatings.

Table 2: Destiny Deluge Tank – Average Dry Film Thickness Measurements (Final Inspection)

Average DFT of each Five Spot Measurements– Dry Film Thickness (dft) reported in mils				
7.0	6.2	6.3	6.2	7.5
7.3	7.2	5.9	7.0	8.3
6.9	6.3	7.3	8.2	6.6
6.6	7.7	6.2	8.9	9.8
Average dft of all Spot Measurement Averages (avg. of 300 individual gage rdgs.)				7.17 mils
Less Average dft from In-Progress Inspection (avg. of 219 individual gage rdgs.)				4.81 mils
Average DFT of Sherwin Williams Corothane I Ironox A top coat				2.36 mils

Table 3 shows the average dft of each five spot measurements, (encompassing 219 individual gage readings), taken on the Destiny Tank during the in-progress inspection in September 2005. The individual gage readings are included in the In-Progress Report.

Table 3: Destiny Deluge Tank – Average Dry Film Thickness Measurements (In-Progress Inspection)

Average DFT of each Five Spot Measurements– Dry Film Thickness (dft) reported in mils				
5.3	4.3	4.4	4.6	5.2
4.2	4.6	4.1	6.1	5.9
5.1	3.8	4.5	6.3	3.8
Average dft of all Spot Measurement Averages				4.81 mils*

Tables showing the individual gage readings taken on the Destiny Tank during the final inspection are shown in the pages that follow.

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Destiny Tank - Dry Film Thickness Measurement (Final Inspection)					
Structure & Location	Final Inspection Ft. Campbell Batch 1 10/24/2005 Destiny Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	10.3	7.6	6.8	6.7	6.6
Gage Reading #2	7.9	6.7	6.5	5.1	5.9
Gage Reading #3	8.3	8.0	7.3	4.1	6.5
Average DFT	8.8	7.4	6.9	5.3	6.3
Average of All Five Spot Measurements					7.0

Structure & Location	Final Inspection Ft. Campbell Batch 2 10/24/2005 Destiny Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	7.7	8.3	7.3	5.8	7.4
Gage Reading #2	9.7	8.1	8.2	7.5	5.9
Gage Reading #3	7.2	7.6	6.8	6.1	6.5
Average DFT	8.2	8.0	7.4	6.5	6.6
Average of All Five Spot Measurements					7.3

Structure & Location	Final Inspection Ft. Campbell Batch3 10/24/2005 Destiny Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	6.0	7.7	7.5	5.2	6.9
Gage Reading #2	5.8	8.2	6.5	7.2	6.4
Gage Reading #3	7.9	7.0	6.5	6.7	8.6
Average DFT	6.6	7.6	6.8	6.4	7.3
Average of All Five Spot Measurements					6.9

Structure & Location	Final Inspection Ft. Campbell Batch 4 10/24/2005 Destiny Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	5.7	9.7	6.7	6.4	8.0
Gage Reading #2	6.1	7.6	8.2	4.9	4.7
Gage Reading #3	5.9	6.1	5.8	6.9	5.8
Average DFT	5.9	7.8	6.9	6.1	6.2
Average of All Five Spot Measurements					6.6

Structure & Location	Final Inspection Ft. Campbell Batch 5 10/24/2005 Destiny Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	7.0	6.2	6.4	4.3	7.5
Gage Reading #2	7.1	5.6	5.2	4.9	7.0
Gage Reading #3	7.6	6.3	4.9	6.8	5.9
Average DFT	7.2	6.0	5.5	5.3	6.8
Average of All Five Spot Measurements					6.2

Structure & Location	Final Inspection Ft. Campbell Batch 6 10/24/2005 Destiny Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	4.7	5.9	7.5	6.5	9.3
Gage Reading #2	5.9	6.7	7.5	6.9	8.6
Gage Reading #3	5.1	6.3	8.4	8.2	10.0
Average DFT	5.2	6.3	7.8	7.2	9.3
Average of All Five Spot Measurements					7.2

Structure & Location	Final Inspection Ft. Campbell Batch 7 10/24/2005 Destiny Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	6.0	5.2	5.4	7.8	5.7
Gage Reading #2	5.7	5.9	6.6	8.2	6.8
Gage Reading #3	5.6	6.3	6.2	7.3	5.5
Average DFT	5.8	5.8	6.1	7.8	6.0
Average of All Five Spot Measurements					6.3

Structure & Location	Final Inspection Ft. Campbell Batch 8 10/24/2005 Destiny Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	5.8	7.9	7.0	11.9	5.9
Gage Reading #2	6.6	5.1	7.5	12.6	6.0
Gage Reading #3	7.2	6.7	7.1	11.5	6.2
Average DFT	6.5	6.6	7.2	12.0	6.0
Average of All Five Spot Measurements					7.7

Structure & Location	Final Inspection Ft. Campbell Batch 9 10/24/2005 Destiny Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	7.8	7.7	4.2	5.9	5.9
Gage Reading #2	5.7	9.0	4.6	5.6	4.6
Gage Reading #3	5.2	9.1	6.4	5.5	7.8
Average DFT	6.2	8.6	5.1	5.7	6.1
Average of All Five Spot Measurements					6.3

Structure & Location	Final Inspection Ft. Campbell Batch 10 10/24/2005 Destiny Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	7.4	5.8	5.7	5.2	6.6
Gage Reading #2	4.8	6.1	6.6	5.7	6.9
Gage Reading #3	4.9	5.9	4.7	6.4	5.5
Average DFT	5.7	5.9	5.7	5.8	6.3
Average of All Five Spot Measurements					5.9

Structure & Location	Final Inspection Ft. Campbell Batch 11 10/24/2005 Destiny Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	6.7	8.4	8.0	7.7	6.3
Gage Reading #2	6.3	6.8	5.8	9.7	6.7
Gage Reading #3	5.4	7.4	6.7	10.6	6.5
Average DFT	6.1	7.5	6.8	9.3	6.5
Average of All Five Spot Measurements					7.3

Structure & Location	Final Inspection Ft. Campbell Batch 12 10/24/2005 Destiny Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	6.4	7.2	6.9	5.7	5.9
Gage Reading #2	5.0	6.9	6.6	6.9	5.2
Gage Reading #3	6.2	4.7	6.8	5.6	7.4
Average DFT	5.9	6.3	6.8	6.1	6.2
Average of All Five Spot Measurements					6.2

Structure & Location	Final Inspection Ft. Campbell Batch 13 10/24/2005 Destiny Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	4.9	6.4	7.3	5.8	5.4
Gage Reading #2	7.7	7.6	4.7	5.7	7.1
Gage Reading #3	5.8	5.7	6.2	6.3	5.7
Average DFT	6.1	6.6	6.1	5.9	6.1
Average of All Five Spot Measurements					6.2

Structure & Location	Final Inspection Ft. Campbell Batch 14 10/24/2005 Destiny Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	8.9	5.4	9.1	6.6	7.5
Gage Reading #2	7.9	7.5	6.9	6.4	6.0
Gage Reading #3	7.5	7.6	6.3	5.5	6.6
Average DFT	8.1	6.8	7.4	6.2	6.7
Average of All Five Spot Measurements					7.0

Structure & Location	Final Inspection Ft. Campbell Batch 15 10/24/2005 Destiny Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	7.5	7.6	8.7	7.7	6.8
Gage Reading #2	8.9	8.2	6.4	10.5	8.2
Gage Reading #3	8.5	8.2	8.7	6.0	10.4
Average DFT	8.3	8.0	7.9	8.1	8.5
Average of All Five Spot Measurements					8.2

Structure & Location	Final Inspection Ft. Campbell Batch 16 10/24/2005 Destiny Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	9.2	7.5	8.3	9.6	10.8
Gage Reading #2	5.5	6.1	8.2	10.0	7.5
Gage Reading #3	8.1	8.0	18.8	8.8	7.2
Average DFT	7.6	7.2	11.8	9.5	8.5
Average of All Five Spot Measurements					8.9

Structure & Location	Final Inspection Ft. Campbell Batch 17 10/24/2005 Destiny Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	7.9	7.1	7.2	6.7	9.6
Gage Reading #2	6.8	8.1	7.4	5.5	5.7
Gage Reading #3	10.1	9.1	7.1	6.9	7.7
Average DFT	8.3	8.1	7.2	6.4	7.7
Average of All Five Spot Measurements					7.5

Structure & Location	Final Inspection Ft. Campbell Batch 18 10/24/2005 Destiny Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	9.1	7.5	5.3	9.2	8.7
Gage Reading #2	7.1	12.9	7.7	6.1	9.5
Gage Reading #3	7.5	9.4	8.3	8.1	n/a
Average DFT	7.9	9.9	7.1	7.8	9.1
Average of All Five Spot Measurements					8.3

Structure & Location	Final Inspection Ft. Campbell Batch 19 10/24/2005 Destiny Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	5.8	4.9	6.7	9.2	7.6
Gage Reading #2	6.4	8.1	5.7	6.7	7.2
Gage Reading #3	6.0	5.6	7.5	7.4	4.7
Average DFT	6.1	6.2	6.6	7.8	6.5
Average of All Five Spot Measurements					6.6

Structure & Location	Final Inspection Ft. Campbell Batch 20 10/24/2005 Destiny Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	11.4	10.5	8.0	8.5	10.6
Gage Reading #2	9.2	11.0	9.9	7.6	12.3
Gage Reading #3	9.4	9.2	9.5	9.7	9.5
Average DFT	10.0	10.2	9.1	8.6	10.8
Average of All Five Spot Measurements					9.8

SABRE DELUGE TANK – BUILDING 6623A

Figure 11: Sabre Deluge Tank after application of the coating system by MANTA

GENERAL CONDITION: The exterior of the Sabre Deluge Tank consists of approximately 5,806 square feet. It is constructed of steel and was previously painted. MANTA applied the Sherwin Williams Corothane I Mastic primer and the Sherwin Williams Corothane I Ironox A topcoat on this structure.

MARK 10 performed a visual inspection of the Sabre Deluge Tank and measured the coating dry film thickness. In regards to the visual inspection of the Sabre Deluge Tank, the following general observations were made:

- Bubbling, craters, and pinholes were observed in some areas of the topcoat
- Local, isolated runs and sags were seen in areas with excessive finish coat dft
- Holidays and misses were observed in a few areas
- A large section of roller nap was embedded in the finish coat in one area

The finish coat application was completed while MARK 10 was on site for the in-progress inspection; however the dft readings were not taken on the finish coat until the final

inspection since the film was still soft when MARK 10 completed the in-progress inspection.

The finish coat film appeared to bubble and form pinholes and craters in some cases after it was applied. This appeared to be occurring in areas where the SW Corothane I Ironox A finish coat was applied at excessively high dry film thicknesses. Overall the dry film thickness on the tank is within the manufacturers recommended dft; however, there are isolated areas where the dft exceeds the recommended dft. Figure 12 shows an example of bubbling, craters, small pinholes and several runs / sags.

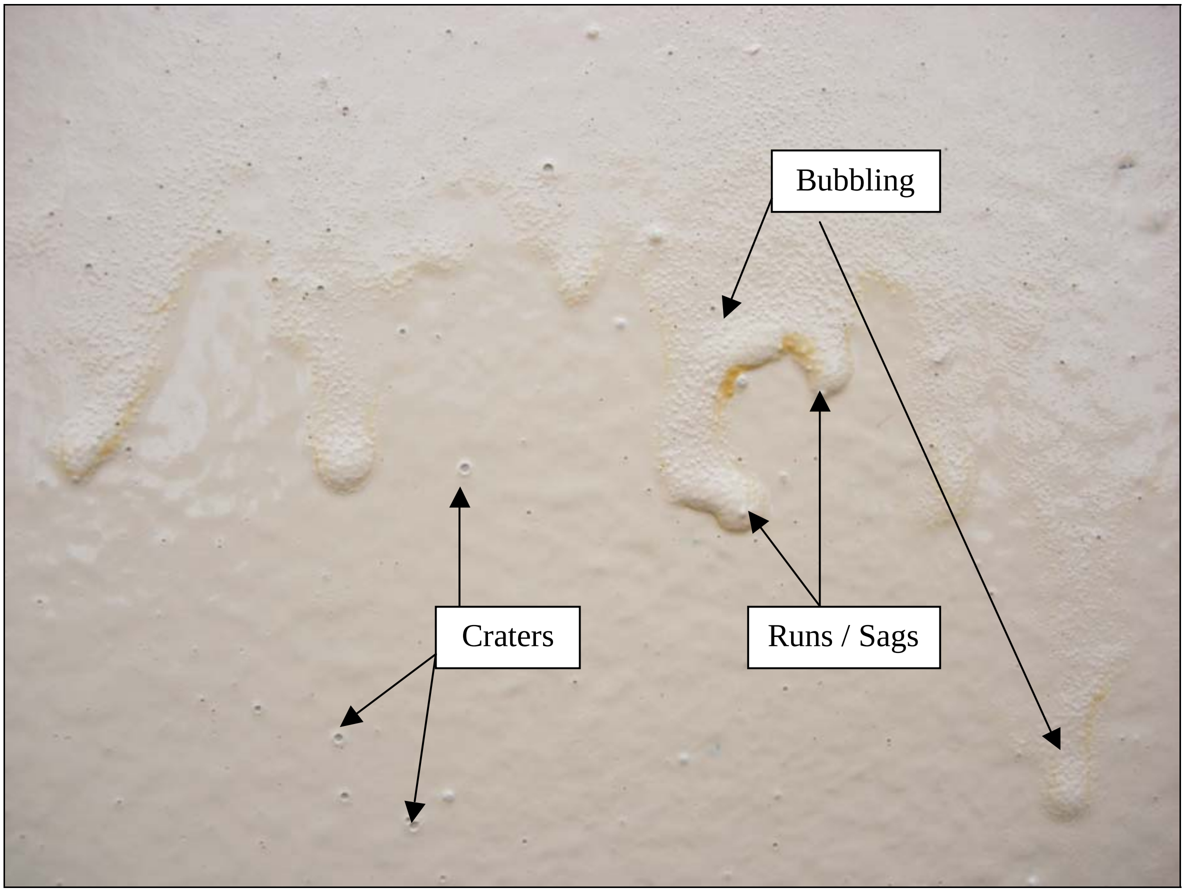

Figure 12: Foaming, craters, runs and sags in finish coat on Sabre Deluge Tank

The runs and sags seen in Figure 12 are located in the finish coat. They are not telegraphing through from a previous coat. Over time the excessive thickness in these areas may result in local premature coating failure (e.g. cracking or delamination) due to internal stress as the coating is exposed to the thermal contraction and expansion of the tank.

During the final inspection a few holidays in the topcoat were observed in an area adjacent to the ladder. These holidays are located between the Sherwin Williams Corothane I Ironox A topcoat and the Sherwin Williams Corothane I Mastic primer (see Figure 13).

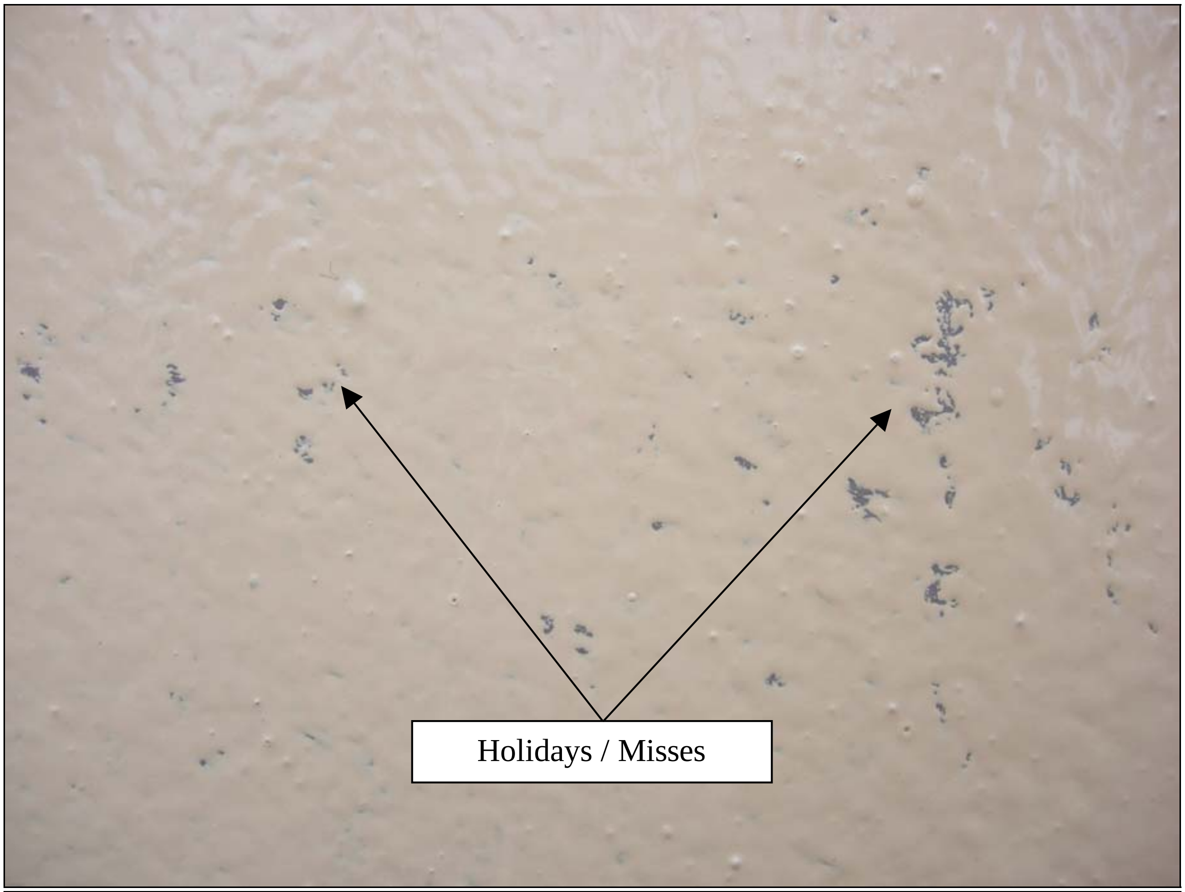

Figure 13: Holidays / missed areas in the Sherwin Williams Corothane I Ironox finish coat

Figure 14: Holidays / misses

A large section of roller nap was embedded in the finish coat in a few areas of the tank ladder assembly. The roller nap was cut out of the film leaving an area with crater-like pores in the film. (See Figure 16 and Figure 15.)

Figure 16: Roller nap in paint film

Figure 15: Roller nap removed

DRY FILM THICKNESS MEASUREMENTS:

MARK 10 measured the dry film thickness on the Sabre Deluge Tank using a Positector 6000 FN3 gage. The dft figures provided in Table 4 represent the average of each five spot measurements taken on 20 different areas of the tank. Since each spot measurement consists of three individual gage readings, and five spot measurements are taken in each area measured, a total of 299 individual gage readings were taken. (Note: In one area only 14 individual gage readings were obtained.)

The average of the final inspection dft measurements, (as shown in Table 4), on the Sabre Tank was 8.69 mils. This figure includes the two coats applied by MANTA and the previously applied coatings. Subtracting the in-progress inspection average dft measurement of 5.19 mils dft from the 8.69 mil final inspection average dft provides an average dft for the topcoat of 3.5 mils. This dft is at the upper limit of the manufacturer's recommended dry film thickness range.

The dft figures provided in Table 5 represent the average of each five spot measurements taken on sixteen different areas of the tank. Since each spot measurement consists of three individual gage readings, and five spot measurements were taken in each area measured, a total of 240 gage readings were taken. The average dft for these measurements was 5.38 mils.

Table 4: Sabre Deluge Tank – Average Dry Film Thickness Measurements (Final Inspection)

Average DFT of each Five Spot Measurements– Dry Film Thickness (dft) reported in mils				
8.5	10.6	10.2	6.8	6.2
7.9	12.3	9.7	6.3	6.3
9.8	9.5	8.3	6.2	6.2
15.3	9.8	9.5	7.4	7.0
Average dft of all Spot Measurement Averages (avg. of 299 individual gage rdgs.)				8.69 mils
Less Average dft from In-Progress Inspection (avg. of 240 individual gage rdgs.)				5.19 mils
Average DFT of Sherwin Williams Corothane I Ironox A top coat				3.50 mils

Table 5 shows the average dft of each five spot measurements, taken in 16 different areas, (encompassing 240 individual gage readings), taken on the Sabre Tank during the In-Progress inspection in September 2005. The value of each individual gage reading is shown in the In-Progress Report.

Table 5: Sabre Deluge Tank – Average Dry Film Thickness Measurements (In-Progress Inspection)

Average DFT of each Five Spot Measurements– Dry Film Thickness (dft) reported in mils				
6.5	7.3	4.8	4.5	
5.4	5.1	5.2	4.4	
5.0	4.0	5.4	4.5	
5.5	4.5	6.7	4.2	
Average dft of all 16 Spot Measurement Averages				5.19 mils*

* Includes previous coatings on the surface when the primer was applied. Does not include topcoat.

Tables showing the individual gage readings taken on the Sabre Deluge Tank during the final inspection are shown in the pages that follow.

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Sabre Tank - Dry Film Thickness Measurement (Final Inspection)					
Structure & Location	Final Inspection Ft. Campbell Batch 41 10/24/2005 Sabre Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	8.1	9.7	9.9	7.8	6.8
Gage Reading #2	7.6	8.4	9.1	9.3	7.9
Gage Reading #3	8.0	7.4	11.6	7.1	8.5
Average DFT	7.9	8.5	10.2	8.1	7.7
Average of All Five Spot Measurements					8.5

Structure & Location	Final Inspection Ft. Campbell Batch 42 10/24/2005 Sabre Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	7.3	9.3	9.2	7.5	7.1
Gage Reading #2	7.3	8.0	8.4	7.4	6.4
Gage Reading #3	13.9	8.6	5.9	5.4	6.9
Average DFT	9.5	8.6	7.8	6.8	6.8
Average of All Five Spot Measurements					7.9

Structure & Location	Final Inspection Ft. Campbell Batch 43 10/24/2005 Sabre Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	14.1	7.7	9.5	9.4	11.7
Gage Reading #2	13.5	8.5	10.7	8.1	10.7
Gage Reading #3	10.0	7.6	9.8	6.4	8.9
Average DFT	12.5	7.9	10.0	8.0	10.4
Average of All Five Spot Measurements					9.8

Structure & Location	Final Inspection Ft. Campbell Batch 44 10/24/2005 Sabre Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	14.6	14.0	15.7	14.7	13.3
Gage Reading #2	16.1	10.8	16.1	16.4	14.2
Gage Reading #3	14.7	15.9	13.6	18.4	20.9
Average DFT	15.1	13.6	15.1	16.5	16.1
Average of All Five Spot Measurements					15.3

Structure & Location	Final Inspection Ft. Campbell Batch 45 10/24/2005 Sabre Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	9.1	7.5	10.9	13.5	13.7
Gage Reading #2	11.1	8.7	8.5	11.1	12.5
Gage Reading #3	9.1	9.9	10.6	12.0	11.0
Average DFT	9.8	8.7	10.0	12.2	12.4
Average of All Five Spot Measurements					10.6

Structure & Location	Final Inspection Ft. Campbell Batch 46 10/24/2005 Sabre Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	13.4	12.8	15.3	13.5	8.9
Gage Reading #2	12.3	13.4	17.2	10.5	8.8
Gage Reading #3	11.2	12.2	11.2	14.4	8.7
Average DFT	12.3	12.8	14.6	12.8	8.8
Average of All Five Spot Measurements					12.3

Structure & Location	Final Inspection Ft. Campbell Batch 47 10/24/2005 Sabre Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	6.5	9.4	9.4	11.2	7.3
Gage Reading #2	9.8	9.5	8.2	13.0	13.4
Gage Reading #3	8.5	8.5	9.0	7.6	11.2
Average DFT	8.3	9.1	8.9	10.6	10.6
Average of All Five Spot Measurements					9.5

Structure & Location	Final Inspection Ft. Campbell Batch 48 10/24/2005 Sabre Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	11.7	10.7	8.3	12.0	9.1
Gage Reading #2	9.4	11.2	8.2	9.9	9.3
Gage Reading #3	10.1	9.6	8.1	9.7	9.6
Average DFT	10.4	10.5	8.2	10.5	9.3
Average of All Five Spot Measurements					9.8

Structure & Location	Final Inspection Ft. Campbell Batch 49 10/24/2005 Sabre Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	8.6	9.1	12.2	9.4	8.6
Gage Reading #2	10.6	10.7	10.0	9.5	10.0
Gage Reading #3	9.3	11.7	9.5	13.4	10.1
Average DFT	9.5	10.5	10.6	10.8	9.6
Average of All Five Spot Measurements					10.2

Structure & Location	Final Inspection Ft. Campbell Batch 50 10/24/2005 Sabre Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	9.9	9.2	8.7	10.0	9.1
Gage Reading #2	9.8	10.6	8.1	9.4	9.2
Gage Reading #3	11.1	10.2	9.8	9.2	11.3
Average DFT	10.3	10.0	8.9	9.5	9.9
Average of All Five Spot Measurements					9.7

Structure & Location	Final Inspection Ft. Campbell Batch51 10/24/2005 Sabre Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	5.6	8.3	7.4	8.3	7.2
Gage Reading #2	7.7	8.7	10.6	8.3	9.2
Gage Reading #3	6.4	10.8	9.3	7.9	8.5
Average DFT	6.6	9.3	9.1	8.2	8.3
Average of All Five Spot Measurements					8.3

Structure & Location	Final Inspection Ft. Campbell Batch 52 10/24/2005 Sabre Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	9.4	7.9	7.5	15.5	8.1
Gage Reading #2	8.4	9.0	9.7	8.2	10.0
Gage Reading #3	8.4	10.1	10.4	10.6	n/a
Average DFT	8.7	9.0	9.2	11.4	9.1
Average of All Five Spot Measurements					9.5

Structure & Location	Final Inspection Ft. Campbell Batch 53 10/24/2005 Sabre Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	6.9	7.0	7.4	7.0	6.1
Gage Reading #2	6.0	8.5	7.0	4.9	6.0
Gage Reading #3	6.1	7.0	7.8	6.4	8.0
Average DFT	6.3	7.5	7.4	6.1	6.7
Average of All Five Spot Measurements					6.8

Structure & Location	Final Inspection Ft. Campbell Batch 54 10/24/2005 Sabre Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	6.8	6.8	4.6	6.8	5.5
Gage Reading #2	6.8	6.8	5.9	7.9	6.2
Gage Reading #3	6.0	6.7	6.4	6.3	5.5
Average DFT	6.5	6.8	5.6	7.0	5.7
Average of All Five Spot Measurements					6.3

Structure & Location	Final Inspection Ft. Campbell Batch 55 10/24/2005 Sabre Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	6.6	7.4	4.8	7.9	4.4
Gage Reading #2	4.7	8.3	5.1	6.9	4.2
Gage Reading #3	5.8	6.0	8.4	7.2	5.8
Average DFT	5.7	7.2	6.1	7.3	4.8
Average of All Five Spot Measurements					6.2

Structure & Location	Final Inspection Ft. Campbell Batch 56 10/24/2005 Sabre Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	8.2	5.2	5.2	8.6	8.8
Gage Reading #2	6.0	6.0	6.6	6.9	12.0
Gage Reading #3	6.6	6.7	10.5	6.4	7.7
Average DFT	6.9	6.0	7.4	7.3	9.5
Average of All Five Spot Measurements					7.4

Structure & Location	Final Inspection Ft. Campbell Batch 57 10/24/2005 Sabre Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	6.0	6.1	5.4	5.5	7.1
Gage Reading #2	4.7	4.9	5.0	7.7	6.7
Gage Reading #3	5.9	5.1	6.5	10.6	6.4
Average DFT	5.5	5.4	5.6	7.9	6.7
Average of All Five Spot Measurements					6.2

Structure & Location	Final Inspection Ft. Campbell Batch 58 10/24/2005 Sabre Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	6.0	6.1	5.4	5.5	7.2
Gage Reading #2	4.7	4.9	5.0	7.7	7.1
Gage Reading #3	5.9	5.1	6.5	10.6	6.7
Average DFT	5.5	5.4	5.6	7.9	7.0
Average of All Five Spot Measurements					6.3

Structure & Location	Final Inspection Ft. Campbell Batch 59 10/24/2005 Sabre Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	6.2	6.3	7.3	4.9	6.4
Gage Reading #2	6.0	7.4	5.2	5.9	7.2
Gage Reading #3	6.1	6.8	4.5	6.8	6.6
Average DFT	6.1	6.8	5.7	5.9	6.7
Average of All Five Spot Measurements					6.2

Structure & Location	Final Inspection Ft. Campbell Batch 60 10/24/2005 Sabre Tank				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	6.6	6.7	7.2	6.7	7.5
Gage Reading #2	6.1	7.4	6.4	7.7	6.3
Gage Reading #3	6.3	7.7	7.2	7.5	7.5
Average DFT	6.3	7.3	6.9	7.3	7.1
Average of All Five Spot Measurements					7.0

HANGAR #1 – BUILDING 7161

Figure 17: Hangar #1 upon Completion

GENERAL CONDITION: The exterior surface of Hangar #1 consists of 16,401 square feet of corrugated galvanized metal that was previously coated. MANTA applied the Sherwin Williams Corothane I Mastic primer and the Sherwin Williams Corothane I Ironox A topcoat to this structure. Both of these coatings are moisture-cured polyurethanes.

In October 2005, MARK 10 performed a visual inspection of Hangar #1 and measured the dry film thickness of the total system. During the in-progress inspection, in September 2005, the dry film thickness of the primer and previously applied coatings on Hangar #1 were measured.

At the time of the in-progress inspection, in September 2005, numerous issues were identified with Hangar #1. The primary issue observed at the time was loosely adhered paint that was not removed in accordance with the requirements of SSPC SP3. MANTA has done an outstanding job of correcting this issue. During the final inspection, no visible detrimental issues with MANTA’s work were observed on Hangar #1.

The pictures shown below provide graphic examples of the effort expended by MANTA during the time between the in-progress inspection and the final inspection. The pictures on the right (Figure 19 and Figure 21) were taken during the in-progress inspection. They show extensive loose paint that required removal. The pictures on the left (Figure 18 and Figure 20) show the Hangar #1 surfaces at the time of the final inspection.

Figure 18: Final Inspection (Hangar #1)

Figure 19: In-Progress Inspection (Hangar#1)

Figure 20: Final Inspection (Hangar #1)

Figure 21: In-Progress Inspection (Hangar#1)

DRY FILM THICKNESS MEASUREMENTS:

MARK 10 measured the dry film thickness on Hangar #1 using a Positector 6000 FN3 gage. The dft figures provided in Table 6 represent the average of each five spot measurements taken on 22 different areas of the tank. Since each spot measurement consists of at least three individual gage readings, and five spot measurements are taken in each area measured, a total of 329 individual gage readings were taken. (Note: In one area only 14 individual gage readings were obtained.)

The average dry film thickness value for Hangar #1, from the final inspection dft measurements, is 9.83 mils. This includes the two coats applied by MANTA and the previously applied coatings. The average dft value from Hangar #1 obtained during the in-progress inspection was 5.38 mils. (See Table 7.) By subtracting the in-progress average dft value from the final inspection average dft value, the average dry film thickness of the finish coat was determined to be 4.45 mils.

At 4.45 mils, the average dry film thickness of the finish coat is higher than the manufacturer's maximum recommended dft of 3.5 mils; however, since extensive remedial work was performed on this structure, including applying additional primer after the loose paint was removed, it is likely that some of this dft that is being reported as the final coat dft is actually an additional coat of the Corothane I Mastic. Since the in-progress dft readings were taken before MANTA performed the corrective work, they do not include the additional Corothane I Mastic that was applied after the repairs; however, the final inspection dft readings do include the unknown value of the additional Corothane I Mastic coating.

Table 6: Hangar #1 – Average Dry Film Thickness Measurements (Final Inspection)

Average DFT of each Five Spot Measurements– Dry Film Thickness (dft) reported in mils				
9.2	11.5	8.0	7.0	7.6
10.9	9.5	10.5	9.9	9.0
13.6	10.9	8.5	12.2	
11.7	9.6	10.2	10.2	
6.6	10.7	9.8	9.1	
Average dft of all Spot Measurement Averages (avg. of 329 individual gage rdgs.)				9.83 mils
Less Average dft from In-Progress Inspection (avg. of 330 individual gage rdgs.)				5.38 mils
Average DFT of Sherwin Williams Corothane I Ironox A top coat				4.45 mils

The dft figures provided in Table 7, (obtained during the in-progress inspection), represent the average of all five spot measurements taken in each area. DFT measurements were

taken on 22 different areas of the hangar. Since each spot measurement consists of three individual gage readings, and five spot measurements are taken in each area measured, a total of 330 individual gage readings were taken. The average dft for these measurements was 5.38 mils.

Table 7: Hangar #1 – Dry Film Thickness Measurements (In-Progress Inspection)

Average DFT of each Five Spot Measurement Areas– Dry Film Thickness (dft) reported in mils				
3.0	7.1	4.9	7.1	7.0
5.2	5.2	6.4	7.4	6.2
3.0	5.1	5.4	4.4	
3.8	6.4	4.7	3.9	
5.0	6.4	5.6	5.1	
Average dft of all Spot Measurement Averages				5.38 mils*

* Includes previous coatings on the surface when the primer was applied.

The individual gage reading dft measurements obtained during the final inspection for Hangar #1 are shown in the following pages. The individual dft gage readings obtained during the in-progress inspection are included with the In-Progress Inspection Report.

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Hangar #1 - Dry Film Thickness Measurement (Final Inspection)					
Structure & Location	Final Inspection Ft. Campbell Batch 61 10/24/2005 Hangar #1				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	6.3	11.9	7.1	10.9	11.3
Gage Reading #2	7.5	8.8	7.1	9.8	7.6
Gage Reading #3	11.5	7.1	11.8	10.3	8.3
Average DFT	8.4	9.3	8.7	10.3	9.1
Average of All Five Spot Measurements					9.2

Structure & Location	Final Inspection Ft. Campbell Batch 62 10/24/2005 Hangar #1				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	15.1	13.2	16.1	6.5	8.2
Gage Reading #2	11.4	12.6	10.0	7.1	13.9
Gage Reading #3	12.0	8.8	10.2	7.9	11.2
Average DFT	12.8	11.5	12.1	7.2	11.1
Average of All Five Spot Measurements					10.9

Structure & Location	Final Inspection Ft. Campbell Batch 63 10/24/2005 Hangar #1				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	10.9	12.8	14.1	15.6	11.4
Gage Reading #2	11.8	23.1	15.1	14.1	10.0
Gage Reading #3	14.2	16.7	9.9	11.8	12.0
Average DFT	12.3	17.5	13.0	13.8	11.1
Average of All Five Spot Measurements					13.6

Structure & Location	Final Inspection Ft. Campbell Batch 64 10/24/2005 Hangar #1				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	8.4	10.9	15.5	11.5	10.1
Gage Reading #2	10.1	16.6	13.8	10.4	6.5
Gage Reading #3	16.9	12.8	10.0	11.9	9.8
Average DFT	11.8	13.4	13.1	11.3	8.8
Average of All Five Spot Measurements					11.7

Structure & Location	Final Inspection Ft. Campbell Batch 65 10/24/2005 Hangar #1				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	5.9	8.0	4.8	4.8	6.7
Gage Reading #2	6.7	7.7	7.7	6.0	7.6
Gage Reading #3	6.7	8.0	4.9	6.6	6.3
Average DFT	6.4	7.9	5.8	5.8	6.9
Average of All Five Spot Measurements					6.6

Structure & Location	Final Inspection Ft. Campbell Batch 66 10/24/2005 Hangar #1				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	9.4	10.9	11.3	11.4	13.3
Gage Reading #2	11.9	12.3	10.3	8.4	13.1
Gage Reading #3	14.2	9.5	10.7	12.5	13.8
Average DFT	11.8	10.9	10.8	10.8	13.4
Average of All Five Spot Measurements					11.5

Structure & Location	Final Inspection Ft. Campbell Batch 67 10/24/2005 Hangar #1				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	10.2	7.7	11.0	9.5	9.4
Gage Reading #2	10.3	9.7	9.4	9.8	7.5
Gage Reading #3	8.7	12.9	7.7	9.6	9.2
Average DFT	9.7	10.1	9.4	9.6	8.7
Average of All Five Spot Measurements					9.5

Structure & Location	Final Inspection Ft. Campbell Batch 68 10/24/2005 Hangar #1				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	9.3	7.7	11.6	13.5	13.3
Gage Reading #2	9.3	13.3	13.0	12.8	12.0
Gage Reading #3	6.5	12.3	9.1	9.3	n/a
Average DFT	8.4	11.1	11.2	11.9	12.7
Average of All Five Spot Measurements					10.9

Structure & Location	Final Inspection Ft. Campbell Batch 69 10/24/2005 Hangar #1				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	7.9	6.9	9.4	10.0	11.5
Gage Reading #2	9.3	11.6	10.2	10.5	7.4
Gage Reading #3	10.3	8.2	10.4	7.4	12.6
Average DFT	9.2	8.9	10.0	9.3	10.5
Average of All Five Spot Measurements					9.6

Structure & Location	Final Inspection Ft. Campbell Batch 70 10/24/2005 Hangar #1				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	20.5	9.6	8.7	13.3	6.9
Gage Reading #2	10.1	6.8	9.6	16.0	10.2
Gage Reading #3	10.7	10.5	10.0	8.3	8.7
Average DFT	13.8	9.0	9.4	12.5	8.6
Average of All Five Spot Measurements					10.7

Structure & Location	Final Inspection Ft. Campbell Batch 71 10/24/2005 Hangar #1				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	10.7	9.3	6.7	9.7	5.9
Gage Reading #2	8.9	8.7	7.1	8.7	8.9
Gage Reading #3	9.0	6.4	9.4	6.7	4.4
Average DFT	9.5	8.1	7.7	8.4	6.4
Average of All Five Spot Measurements					8.0

Structure & Location	Final Inspection Ft. Campbell Batch 72 10/24/2005 Hangar #1				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	10.3	10.4	11.0	8.6	9.3
Gage Reading #2	10.9	10.7	8.8	9.3	10.3
Gage Reading #3	10.6	10.5	12.4	14.9	9.3
Average DFT	10.6	10.5	10.7	10.9	9.6
Average of All Five Spot Measurements					10.5

Structure & Location	Final Inspection Ft. Campbell Batch 73 10/24/2005 Hangar #1				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	10.2	7.5	8.3	9.1	7.7
Gage Reading #2	9.6	7.4	10.8	7.9	7.4
Gage Reading #3	9.3	8.0	9.9	8.6	6.5
Average DFT	9.7	7.6	9.7	8.5	7.2
Average of All Five Spot Measurements					8.5

Structure & Location	Final Inspection Ft. Campbell Batch 74 10/24/2005 Hangar #1				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	14.1	7.8	9.8	8.0	8.1
Gage Reading #2	8.4	11.0	11.1	8.3	7.8
Gage Reading #3	9.6	14.6	11.9	8.6	14.1
Average DFT	10.7	11.1	10.9	8.3	10.0
Average of All Five Spot Measurements					10.2

Structure & Location	Final Inspection Ft. Campbell Batch 75 10/24/2005 Hangar #1				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	7.5	10.9	8.1	9.3	11.1
Gage Reading #2	9.5	10.1	11.5	10.4	10.1
Gage Reading #3	10.1	8.1	10.4	10.4	9.2
Average DFT	9.0	9.7	10.0	10.0	10.1
Average of All Five Spot Measurements					9.8

Structure & Location	Final Inspection Ft. Campbell Batch 76 10/24/2005 Hangar #1				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	5.5	7.8	7.7	8.5	6.6
Gage Reading #2	7.9	7.0	7.0	6.2	4.6
Gage Reading #3	7.6	8.5	6.9	7.1	5.8
Average DFT	7.0	7.8	7.2	7.3	5.7
Average of All Five Spot Measurements					7.0

Structure & Location	Final Inspection Ft. Campbell Batch 77 10/24/2005 Hangar #1				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	8.5	10.3	8.1	7.7	7.1
Gage Reading #2	26.2	9.3	6.7	11.6	10.7
Gage Reading #3	15.3	4.5	8.2	6.1	8.8
Average DFT	16.7	8.0	7.7	8.5	8.9
Average of All Five Spot Measurements					9.9

Structure & Location	Final Inspection Ft. Campbell Batch 78 10/24/2005 Hangar #1				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	11.9	13.0	11.9	7.7	16.5
Gage Reading #2	11.8	17.7	9.9	8.7	15.6
Gage Reading #3	14.1	14.1	9.4	9.5	10.9
Average DFT	12.6	14.9	10.4	8.6	14.3
Average of All Five Spot Measurements					12.2

Structure & Location	Final Inspection Ft. Campbell Batch 79 10/24/2005 Hangar #1				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	12.6	15.0	7.5	14.2	5.5
Gage Reading #2	13.4	14.0	8.1	11.3	8.1
Gage Reading #3	8.4	13.8	8.4	7.2	5.2
Average DFT	11.5	14.3	8.0	10.9	6.3
Average of All Five Spot Measurements					10.2

Structure & Location	Final Inspection Ft. Campbell Batch 82 10/24/2005 Hangar #1				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	9.8	10.1	6.1	7.6	6.2
Gage Reading #2	11.1	8.9	6.6	8.8	9.2
Gage Reading #3	10.4	8.4	19.4	7.5	6.4
Average DFT	10.4	9.1	10.7	8.0	7.3
Average of All Five Spot Measurements					9.1

Structure & Location	Final Inspection Ft. Campbell Batch 83 10/24/2005 Hangar #1				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	6.8	6.3	9.0	9.0	6.1
Gage Reading #2	10.3	6.6	7.3	6.8	6.3
Gage Reading #3	10.6	5.6	7.1	6.5	9.4
Average DFT	9.2	6.2	7.8	7.4	7.3
Average of All Five Spot Measurements					7.6

Structure & Location	Final Inspection Ft. Campbell Batch 84 10/24/2005 Hangar #1				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	9.7	10.9	12.0	6.3	3.8
Gage Reading #2	10.9	15.2	11.1	7.3	5.0
Gage Reading #3	10.2	8.9	10.9	6.4	7.1
Average DFT	10.3	11.7	11.3	6.7	5.3
Average of All Five Spot Measurements					9.0

HANGAR #2 – BUILDING 7156

Figure 22: Hangar #2 Ft. Campbell upon Completion

GENERAL CONDITION: The exterior surface of Hangar #2 consists of 30,654 square feet of corrugated galvanized siding that was previously coated. MANTA applied the Sherwin Williams Corothane I Mastic primer and the Sherwin Williams Corothane I Ironox A topcoat on Hangar #2.

During the final inspection, MARK 10 performed a visual inspection of Hangar #2 and measured the dry film thickness. In regards to the visual inspection of Hangar #2, the following general observations were made:

- On area was observed with loosely adhered paint
- A few difficult to coat areas were not primed or topcoated by MANTA
- Roller nap and brush hair was observed in the Corothane I Ironox A in some areas
- One of the runs, identified during the in-progress inspection was leveled by cutting off the excess coating material; however, it was not adequately recoated, resulting in crater-like pores in the film.
- Several areas exhibited bubbling in the finish coat film

One area on Hangar #2 was observed, approximately 7 feet from ground level, where the coating was loosely adhered and visibly raised up (Figure 23). Upon closer inspection, the loose coating was removed (Figure 26) and repaired by MANTA (Figure 25). It should be noted that in this area the coating was removed to the bare galvanizing. The galvanizing beneath exhibited a very dark color, uncharacteristic of normal galvanizing.

Figure 23: Loosely adhered coating

Figure 24: Long view after removal

Figure 26: Close-up of area after removal

Figure 25: Close-up after repair

As mentioned in the In-Progress Inspection Report, signs affixed to the building were painted around, leaving the areas beneath them unpainted. In some cases, the signs were riveted to the building, making it impractical to remove them. In another area, the siding near some electrical conduit pipes close to the building was very difficult to access and was not primed or topcoated. The previously applied aluminum coating is visible (Figure 27).

Figure 27: Difficult to access area that was not primed or topcoated

Figure 28: Two cut off coating "runs"

Cutting off the excess coating material leveled one of the runs, identified during the in-progress inspection; however, it was not adequately recoated, resulting in crater-like pores in the film.

In Figure 28, two coating runs are visible in the Sherwin Williams Corothane I Ironox A finish coat. Both runs were removed; however, when the run on the left was removed it left crater-like pores exposed. For the most part, the former run on the right side of the picture was adequately recoated after the run was removed.

Roller nap and brush hairs were observed in several locations on Hangar #2. They were embedded within the topcoat film.

Figure 29: Roller nap in topcoat film

Figure 30: Roller nap in topcoat film

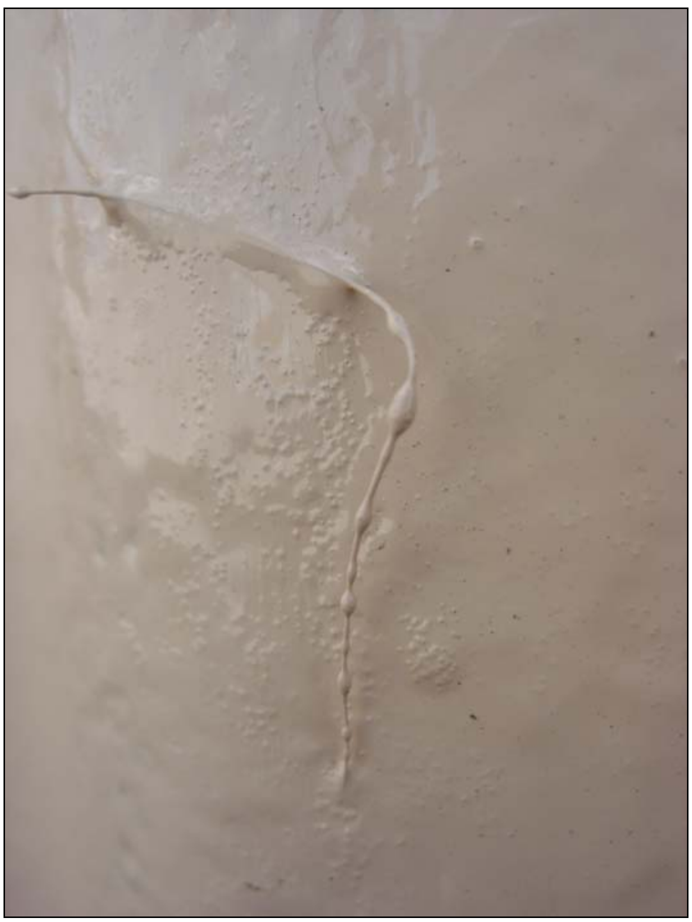

Figure 31: Brush hair in topcoat film

Several areas on Hangar #2 were observed that exhibited a bubbling appearance in the film. The inside of these bubbles are hollow, similar to those shown earlier in this report (see Figure 28). This was also observed in some areas on the Sabre Deluge Tank, generally in areas with higher dry film thickness. Bubbling in moisture-cured urethanes is sometimes caused by rapid CO_2 generation when the coatings are applied in high humidity conditions and at higher dry film thicknesses.

Figure 32: Small bubbles in the Sherwin Williams Corothane I Ironox topcoat

DRY FILM THICKNESS MEASUREMENTS:

MARK 10 measured the dry film thickness on Hangar #2 using a Positector 6000 FN3 gage. The dft figures provided in Table 8 represent the average of each five spot measurement area taken on 40 different areas of the hangar. Since each spot measurement consists of three individual gage readings, and five spot measurements are taken in each area measured, a total of 600 individual gage readings were taken.

The average dry film thickness value for Hangar #2, from the final inspection dft measurements, is 14.82 mils. This includes the two coats applied by MANTA and the previously applied coatings. The average dft value from Hangar #2 obtained during the in-progress inspection was 9.48 mils (see Table 9). By subtracting the in-progress average dft

value from the final inspection average dft value, the average dry film thickness of the finish coat was determined to be 5.34 mils.

Table 8: Hangar #2 – Average Dry Film Thickness Measurements (Final Inspection)

Average DFT of each Five Spot Measurements– Dry Film Thickness (dft) reported in mils				
18.1	18.8	14.1	10.7	13.9
14.0	12.0	11.5	12.6	12.2
14.9	12.4	12.0	13.5	13.4
14.0	12.8	16.1	19.0	15.7
17.3	19.9	14.5	12.9	19.8
15.7	14.8	13.9	14.0	15.3
13.0	13.9	14.9	13.3	15.0
15.0	17.9	15.9	20.6	13.4
Average dft of all Spot Measurement Averages (avg. of 600 individual gage rdgs.)				14.82 mils
Less Average dft from In-Progress Inspection (avg. of 554 individual gage rdgs.)				9.48 mils
Average DFT of Sherwin Williams Corothane I Ironox A top coat				5.34 mils

The 5.34 mil average dry film thickness for the topcoat exceeds the manufacturer's maximum recommended dft of 3.5 mils by 1.8 mils or 51%. This is certainly a cause for concern in regards to the long-term adhesion of this overcoating system, especially in some localized areas of Hangar #2 where the dry film thickness was particularly excessive. As the coating system ages and goes through thermal cycles, additional stress will be placed upon it. The coating systems ability to handle this stress may be reduced by the excessive film thickness and localized delamination may occur.

In addition, excessive dry film thickness adds stress to the underlying coating system. If the underlying coating systems adhesion to the galvanized substrate is weak or marginal, excessive dry film thickness applied on top of it may precipitate or hasten delamination and/or peeling.

In regards to the in-progress dry film thickness measurements that were obtained in September 2005, the dft figures provided in Table 9 represent the average of all five spot measurements taken in each of the area 37 different areas of the hangar that were measured. Since each spot measurement consists of three individual gage readings, and five spot measurements are taken in each area measured, a total of 554 individual gage readings were taken. (In one area only 14 individual gage readings were obtained.) The average dft for these measurements was 9.48 mils.

Table 9: Hangar #2 – Dry Film Thickness Measurements (In-Progress Inspection)

Average DFT of each Five Spot Measurement Areas– Dry Film Thickness (dft) reported in mils				
10.4	9.7	8.2	11.4	9.4
11.0	7.6	8.9	9.1	7.2
11.2	7.8	11.0	9.4	6.9
9.0	7.0	11.7	8.8	9.9
9.4	7.7	12.8	11.4	11.9
7.2	8.8	12.7	9.2	
7.9	10.1	11.1	10.7	
7.5	8.2	11.8	6.7	
Average dft of all Spot Measurement Averages				9.48 mils*

* Includes previous coatings on the surface when the primer was applied.

The individual gage reading dft measurements for Hangar #2 obtained during the final inspection are shown in the following pages. Individual gage readings for the in-progress inspection can be found in the In-Progress Inspection Report.

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Hangar #2 - Dry Film Thickness Measurement (Final Inspection)					
Structure & Location	Final Inspection Ft. Campbell Batch 149 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	16.4	17.6	16.7	21.1	20.1
Gage Reading #2	19.6	18.5	16.0	19.3	18.0
Gage Reading #3	20.6	19.1	16.8	14.9	17.2
Average DFT	18.9	18.4	16.5	18.4	18.4
Average of All Five Spot Measurements					18.1

Structure & Location	Final Inspection Ft. Campbell Batch 150 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	20.0	19.2	20.4	15.9	19.1
Gage Reading #2	19.6	19.5	16.3	16.9	18.0
Gage Reading #3	20.3	17.3	18.0	22.6	18.9
Average DFT	20.0	18.7	18.2	18.5	18.7
Average of All Five Spot Measurements					18.8

Structure & Location	Final Inspection Ft. Campbell Batch 151 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	13.8	11.6	17.9	17.3	15.8
Gage Reading #2	11.5	12.0	15.3	17.9	13.9
Gage Reading #3	10.9	12.4	14.3	12.8	14.7
Average DFT	12.1	12.0	15.8	16.0	14.8
Average of All Five Spot Measurements					14.1

Structure & Location	Final Inspection Ft. Campbell Batch 152 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	10.1	12.2	12.1	11.5	9.6
Gage Reading #2	10.7	11.9	11.0	11.9	14.2
Gage Reading #3	10.2	10.9	9.7	8.5	6.1
Average DFT	10.3	11.7	10.9	10.6	10.0
Average of All Five Spot Measurements					10.7

Structure & Location	Final Inspection Ft. Campbell Batch 153 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	13.0	14.9	16.2	10.4	14.8
Gage Reading #2	13.5	17.8	12.1	13.3	12.4
Gage Reading #3	12.1	16.2	16.3	12.9	11.9
Average DFT	12.9	16.3	14.9	12.2	13.0
Average of All Five Spot Measurements					13.9

Structure & Location	Final Inspection Ft. Campbell Batch 154 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	19.3	8.2	16.7	13.7	13.3
Gage Reading #2	13.1	11.0	11.3	17.4	14.9
Gage Reading #3	9.5	14.5	16.2	15.7	14.5
Average DFT	14.0	11.2	14.7	15.6	14.2
Average of All Five Spot Measurements					14.0

Structure & Location	Final Inspection Ft. Campbell Batch 155 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	14.3	11.6	11.2	10.2	15.5
Gage Reading #2	12.6	11.9	13.9	8.2	11.5
Gage Reading #3	11.9	12.5	12.0	10.0	13.4
Average DFT	12.9	12.0	12.4	9.5	13.5
Average of All Five Spot Measurements					12.0

Structure & Location	Final Inspection Ft. Campbell Batch 156 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	10.7	12.1	10.2	13.3	11.1
Gage Reading #2	10.9	10.8	10.0	14.0	10.1
Gage Reading #3	11.3	11.1	8.9	13.7	14.8
Average DFT	11.0	11.3	9.7	13.7	12.0
Average of All Five Spot Measurements					11.5

Structure & Location	Final Inspection Ft. Campbell Batch 157 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	13.2	12.7	13.6	11.8	14.2
Gage Reading #2	12.2	13.5	13.0	10.7	12.1
Gage Reading #3	15.8	10.2	11.6	12.1	12.6
Average DFT	13.7	12.1	12.7	11.5	13.0
Average of All Five Spot Measurements					12.6

Structure & Location	Final Inspection Ft. Campbell Batch 158 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	13.0	11.3	12.4	11.4	9.6
Gage Reading #2	12.6	13.4	10.8	12.7	9.4
Gage Reading #3	13.7	14.3	14.1	12.1	11.5
Average DFT	13.1	13.0	12.4	12.1	10.2
Average of All Five Spot Measurements					12.2

Structure & Location	Final Inspection Ft. Campbell Batch 159 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	16.7	12.6	12.5	18.2	14.9
Gage Reading #2	14.5	16.8	18.6	12.2	14.0
Gage Reading #3	17.1	12.8	12.0	15.0	15.1
Average DFT	16.1	14.1	14.4	15.1	14.7
Average of All Five Spot Measurements					14.9

Structure & Location	Final Inspection Ft. Campbell Batch 160 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	13.7	16.8	10.2	9.8	12.4
Gage Reading #2	10.9	12.0	11.1	11.1	13.2
Gage Reading #3	13.3	13.7	10.3	11.7	16.1
Average DFT	12.6	14.2	10.5	10.9	13.9
Average of All Five Spot Measurements					12.4

Structure & Location	Final Inspection Ft. Campbell Batch 161 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	14.2	9.4	8.7	10.7	13.6
Gage Reading #2	13.1	9.8	10.7	15.6	13.5
Gage Reading #3	14.2	12.2	9.4	13.4	11.1
Average DFT	13.8	10.5	9.6	13.2	12.7
Average of All Five Spot Measurements					12.0

Structure & Location	Final Inspection Ft. Campbell Batch 162 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	15.3	13.0	15.5	14.9	15.6
Gage Reading #2	14.1	10.2	11.1	12.7	14.4
Gage Reading #3	11.2	13.6	13.8	14.3	12.1
Average DFT	13.5	12.3	13.5	14.0	14.0
Average of All Five Spot Measurements					13.5

Structure & Location	Final Inspection Ft. Campbell Batch 163 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	10.6	10.9	13.0	10.3	13.8
Gage Reading #2	12.5	10.1	15.1	13.4	17.1
Gage Reading #3	12.6	15.1	15.2	12.9	18.8
Average DFT	11.9	12.0	14.4	12.2	16.6
Average of All Five Spot Measurements					13.4

Structure & Location	Final Inspection Ft. Campbell Batch 164 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	14.7	10.6	15.0	11.9	13.0
Gage Reading #2	14.0	12.5	12.6	15.1	14.2
Gage Reading #3	12.6	14.9	17.3	17.4	13.5
Average DFT	13.8	12.7	15.0	14.8	13.6
Average of All Five Spot Measurements					14.0

Structure & Location	Final Inspection Ft. Campbell Batch 165 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	19.6	10.5	12.4	11.6	11.8
Gage Reading #2	10.8	12.0	18.7	11.2	14.0
Gage Reading #3	11.7	10.0	13.4	10.3	14.5
Average DFT	14.0	10.8	14.8	11.0	13.4
Average of All Five Spot Measurements					12.8

Structure & Location	Final Inspection Ft. Campbell Batch 166 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	17.9	13.6	13.3	27.9	19.1
Gage Reading #2	13.9	13.9	13.9	14.7	11.8
Gage Reading #3	14.2	14.6	15.3	22.2	15.0
Average DFT	15.3	14.0	14.2	21.6	15.3
Average of All Five Spot Measurements					16.1

Structure & Location	Final Inspection Ft. Campbell Batch 167 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	18.2	16.2	23.4	19.8	20.3
Gage Reading #2	16.1	17.6	19.5	20.7	17.7
Gage Reading #3	13.7	17.0	20.4	18.6	25.1
Average DFT	16.0	16.9	21.1	19.7	21.0
Average of All Five Spot Measurements					19.0

Structure & Location	Final Inspection Ft. Campbell Batch 168 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	16.0	14.7	20.3	15.3	18.3
Gage Reading #2	14.1	14.7	16.5	15.8	17.3
Gage Reading #3	14.5	12.4	14.6	14.0	17.1
Average DFT	14.9	13.9	17.1	15.0	17.6
Average of All Five Spot Measurements					15.7

Structure & Location	Final Inspection Ft. Campbell Batch 169 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	14.4	15.3	15.2	15.4	21.6
Gage Reading #2	18.8	16.2	16.7	19.1	19.6
Gage Reading #3	18.3	15.1	16.1	16.5	21.9
Average DFT	17.2	15.5	16.0	17.0	21.0
Average of All Five Spot Measurements					17.3

Structure & Location	Final Inspection Ft. Campbell Batch 170 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	18.0	17.5	20.1	15.4	17.1
Gage Reading #2	15.2	34.8	20.1	16.0	26.1
Gage Reading #3	15.9	22.1	16.5	18.1	26.0
Average DFT	16.4	24.8	18.9	16.5	23.1
Average of All Five Spot Measurements					19.9

Structure & Location	Final Inspection Ft. Campbell Batch 171 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	12.0	16.2	14.0	10.8	12.7
Gage Reading #2	26.9	15.6	17.5	9.4	9.3
Gage Reading #3	19.6	14.0	12.6	13.4	14.2
Average DFT	19.5	15.3	14.7	11.2	12.1
Average of All Five Spot Measurements					14.5

Structure & Location	Final Inspection Ft. Campbell Batch 172 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	12.0	11.0	10.9	9.3	15.2
Gage Reading #2	11.0	8.8	14.1	16.4	12.7
Gage Reading #3	13.4	9.9	18.7	14.9	15.9
Average DFT	12.1	9.9	14.6	13.5	14.6
Average of All Five Spot Measurements					12.9

Structure & Location	Final Inspection Ft. Campbell Batch 173 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	17.1	16.8	21.9	20.4	25.6
Gage Reading #2	11.8	23.2	22.9	15.5	20.9
Gage Reading #3	16.3	21.4	24.8	15.4	23.1
Average DFT	15.1	20.5	23.2	17.1	23.2
Average of All Five Spot Measurements					19.8

Structure & Location	Final Inspection Ft. Campbell Batch 174 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	12.1	18.7	12.9	20.1	13.0
Gage Reading #2	14.6	19.7	13.7	19.7	15.8
Gage Reading #3	13.9	15.4	10.9	22.6	11.7
Average DFT	13.5	17.9	12.5	20.8	13.5
Average of All Five Spot Measurements					15.7

Structure & Location	Final Inspection Ft. Campbell Batch 175 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	21.9	19.0	13.2	10.3	11.3
Gage Reading #2	21.3	18.1	13.0	8.7	15.6
Gage Reading #3	14.4	17.3	8.6	13.4	16.0
Average DFT	19.2	18.1	11.6	10.8	14.3
Average of All Five Spot Measurements					14.8

Structure & Location	Final Inspection Ft. Campbell Batch 176 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	12.5	11.2	15.3	18.2	14.0
Gage Reading #2	14.2	13.7	15.6	14.3	10.2
Gage Reading #3	15.5	14.8	12.4	14.9	11.8
Average DFT	14.1	13.2	14.4	15.8	12.0
Average of All Five Spot Measurements					13.9

Structure & Location	Final Inspection Ft. Campbell Batch 177 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	15.2	15.4	11.6	12.8	17.9
Gage Reading #2	12.9	13.4	14.7	14.0	12.9
Gage Reading #3	19.5	15.6	11.5	11.8	11.2
Average DFT	15.9	14.8	12.6	12.9	14.0
Average of All Five Spot Measurements					14.0

Structure & Location	Final Inspection Ft. Campbell Batch 178 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	17.3	17.3	12.6	20.0	18.7
Gage Reading #2	14.4	16.2	14.7	14.2	15.2
Gage Reading #3	14.5	14.1	11.9	15.6	13.2
Average DFT	15.4	15.9	13.1	16.6	15.7
Average of All Five Spot Measurements					15.3

Structure & Location	Final Inspection Ft. Campbell Batch 179 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	11.9	14.4	12.3	15.9	14.4
Gage Reading #2	12.3	13.2	11.8	13.1	11.8
Gage Reading #3	11.3	11.2	13.7	13.5	13.7
Average DFT	11.8	12.9	12.6	14.2	13.3
Average of All Five Spot Measurements					13.0

Structure & Location	Final Inspection Ft. Campbell Batch 180 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	10.0	13.7	12.6	12.6	22.2
Gage Reading #2	12.1	13.5	14.7	16.2	15.7
Gage Reading #3	14.3	19.3	9.7	9.6	11.8
Average DFT	12.1	15.5	12.3	12.8	16.6
Average of All Five Spot Measurements					13.9

Structure & Location	Final Inspection Ft. Campbell Batch 181 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	14.4	13.4	14.1	12.2	19.2
Gage Reading #2	19.6	12.8	14.0	14.3	17.6
Gage Reading #3	11.6	13.8	15.1	15.0	16.9
Average DFT	15.2	13.3	14.4	13.8	17.9
Average of All Five Spot Measurements					14.9

Structure & Location	Final Inspection Ft. Campbell Batch 182 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	10.6	13.2	16.7	13.5	17.5
Gage Reading #2	10.0	14.1	16.1	11.9	10.4
Gage Reading #3	17.3	15.4	9.8	11.2	11.9
Average DFT	12.6	14.2	14.2	12.2	13.3
Average of All Five Spot Measurements					13.3

Structure & Location	Final Inspection Ft. Campbell Batch 183 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	14.2	15.6	12.1	15.2	14.9
Gage Reading #2	15.1	18.0	16.5	14.6	12.8
Gage Reading #3	12.6	15.3	16.8	16.4	15.1
Average DFT	14.0	16.3	15.1	15.4	14.3
Average of All Five Spot Measurements					15.0

Structure & Location	Final Inspection Ft. Campbell Batch 184 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	15.8	17.7	15.3	13.2	14.0
Gage Reading #2	18.4	15.9	14.0	15.1	14.5
Gage Reading #3	12.4	12.8	14.6	14.3	16.8
Average DFT	15.5	15.5	14.6	14.2	15.1
Average of All Five Spot Measurements					15.0

Structure & Location	Final Inspection Ft. Campbell Batch 185 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	19.9	18.7	19.4	15.9	17.6
Gage Reading #2	26.7	14.4	18.2	14.9	15.8
Gage Reading #3	14.4	20.4	19.7	18.7	14.1
Average DFT	20.3	17.8	19.1	16.5	15.8
Average of All Five Spot Measurements					17.9

Structure & Location	Final Inspection Ft. Campbell Batch 188 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	13.5	14.8	14.4	17.2	17.0
Gage Reading #2	13.4	14.2	16.2	17.6	19.3
Gage Reading #3	13.2	16.5	19.7	17.1	14.7
Average DFT	13.4	15.2	16.8	17.3	17.0
Average of All Five Spot Measurements					15.9

Structure & Location	Final Inspection Ft. Campbell Batch 189 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	27.5	20.8	12.7	21.2	20.1
Gage Reading #2	22.6	18.0	14.5	27.0	20.6
Gage Reading #3	24.0	22.9	14.5	22.9	20.2
Average DFT	24.7	20.6	13.9	23.7	20.3
Average of All Five Spot Measurements					20.6

Structure & Location	Final Inspection Ft. Campbell Batch 190 10/25/2005 Hangar #2				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	13.1	12.1	13.7	12.8	14.2
Gage Reading #2	13.7	13.7	14.0	15.1	13.5
Gage Reading #3	15.1	13.1	13.1	12.3	11.6
Average DFT	14.0	13.0	13.6	13.4	13.1
Average of All Five Spot Measurements					13.4

FLIGHT CONTROL TOWER – BUILDING 7212

Figure 33: Close-up of the Flight Control Tower upon Completion

General Condition: The exterior of the Flight Control Tower Building consists approximately 8,250 square feet of previously coated, corrugated, galvanized metal. On this structure MANTA applied a two-coat Tnemec system consisting of the Tnemec Series 135 Chembuild primer and the Tnemec Series 701 Hydroflon fluoropolymer finish coat.

During the final inspection, MARK 10 performed a visual inspection of the surface and measured the dry film thickness of the coatings. The following general observations were made:

- A few pieces of siding are missing or damaged on the edges of the structure (the right hand portion of Figure 33 shows one missing piece).
- Some of the corrugated metal was damaged (i.e. dented).
- One area was observed where the coating was curled or lifted from the surface.
- One areas was observed where the coating was damaged and needed minor repair
- One area was observed with a missed area parallel to a caulked seam around a vent

These missing and/or damaged corner siding pieces and the dented siding represent pre-existent conditions that were present before MANTA began work on this structure and were noted in the In-Progress Inspection Report.

Figure 34: Dented siding on Flight Control Tower beneath the large vent

Figure 35 shows a side view of a raised up area of the coating in an isolated area on the Flight Control Tower. The coating in this area does not conform to the requirements of SSPC SP 3, since it is easily removed when subject to a dull putty knife.

Figure 35: Edges of coating are not adhered to the surface

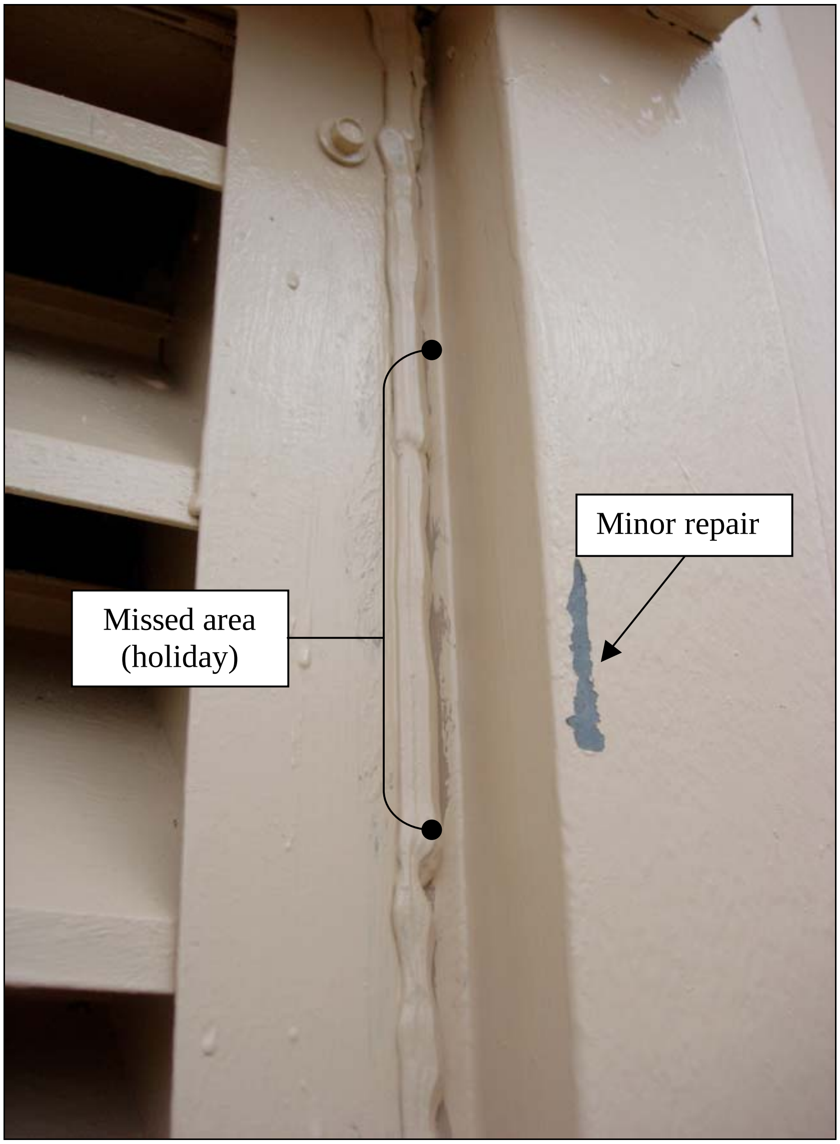

Figure 36: Area with holiday missed area and minor repair

In Figure 36, the back of the Flight Control Tower shows a holiday area running vertically along the caulk seam and a minor delamination requiring touch-up. These isolated problems are minor cosmetic issues and do not characterize the structure. Overall the paint applied on the Flight Control Tower appears to be in very good condition.

The coating in one area near the gate was damaged in two spots. This appears to be due to some type of mechanical damage, possibly related to the gate-latch device. MANTA touched up these damaged spots during the final inspection. If the gate-latch device caused the coating damage, it is likely to reoccur in this area unless it is corrected.

Figure 37: Close-up of the gate and latching device

Figure 38: Long view of gate area

Figure 39: Damage to paint from gate latch

Figure 40: Area after MANTA repaired damage

The series of pictures on this page shows the paint damage on the lower portion of the Flight Control Tower that was repaired by MANTA during the final inspection.

DRY FILM THICKNESS MEASUREMENTS:

MARK 10 measured the dry film thickness on the Flight Control Tower using a Positector 6000 FN3 gage. The dft figures provided in Table 10 represent the average of each five spot measurement area taken on 19 different areas of the flight control tower. Since each spot measurement consists of at least three individual gage readings, and five spot measurements are taken in each area measured, a total of 285 individual gage readings were taken.

The average dry film thickness value for the Flight Control Tower, from the final inspection dft measurements, is 5.9 mils. This includes the two coats applied by MANTA and the previously applied coatings. The average dft value from the Flight Control Tower obtained during the in-progress inspection was 1.59 mils (see Table 11). By subtracting the in-progress average dft value from the final inspection average dft value, the average dry film thickness of the primer (Tnemec Series 135 Chembuild) and the finish coat (Tnemec Series 701 Hydroflon) was determined to be 4.31 mils.

Unlike all the other structures, MANTA had not applied the primer on the Flight Control Tower at the time of the in-progress inspection. For this reason, the 4.31 dft value includes both coats. The manufacturer's minimum recommended dft for this two-coat system is 5.0 mils; therefore, at 4.31 mils the system applied on the Flight Control Tower by MANTA appears slightly low. However, when MARK 10 obtained dry film thickness (dft) measurements on the flight control tower during the in-progress inspection the surface contained a significant amount of chalk, since MANTA had not pressure washed it at the time of the inspection.

During the in-progress inspection, prior to measuring the dft, MARK 10 attempted to remove some of the chalk using a clean rag; however, since all the chalk was not removed, the dft measurements obtained by MARK 10 prior to MANTA's cleaning likely overstated the actual dft that existed after MANTA pressure washed the surface. Therefore, the in-progress inspection average on the FCT of 1.59 mils dft likely overstated the actual dft by approximately 0.25 to 0.50 mils dft.

Subtracting 0.50 mils from the 1.59 mil average provides a modified in-progress inspection average of 1.09 mils dft. Subtracting this value from the 5.9 mil final inspection average dft yields an average two-coat dft of 4.81 mils. This is reasonable close to the 5.0 mil minimum recommended dft; however, it is below the minimum recommended dft. Given the fact that no dft readings were taken after the chalk was removed by MANTA, it is recommended that the dft on the Flight Control Tower be accepted. The overall coating on the structure appears very uniform and trying to add less than ½ mil to the surface is impractical if not impossible by the use of rollers.

Table 10: Flight Control Tower - Average Dry Film Thickness Measurements (Final Inspection)

Average DFT of each Five Spot Measurements– Dry Film Thickness (dft) reported in mils				
7.5	8.5	6.6	6.4	6.3
6.0	7.0	8.2	6.4	5.7
4.5	5.1	5.1	5.1	5.3
7.0	5.7	5.5	5.4	n/a
Average dft of all Spot Measurement Averages (avg. of 285 individual gage rdgs.)				5.90 mils
Less Average dft from In-Progress Inspection (avg. of 210 individual gage rdgs.)				1.59 mils
Average DFT of Sherwin Williams Corothane I Ironox A top coat				4.31 mils

Table 11 provides a summary of the average of the spot measurements averages for 14 different areas on the Flight Control Tower where dft measurement were taken on the flight control tower building during the in-progress inspection. Each spot measurement average is comprised of fifteen individual gage readings. Therefore, these spot measurements represent two hundred ten (210) individual gage readings.

Table 11: Flight Control Tower – Average of each Five Spot Measurement Area (prior to pressure washing) – (In-Progress Inspection)

Average of each Five Spot Measurement Areas – Dry Film Thickness (dft) reported in mils				
1.73	1.51	1.61	2.45	1.10
1.62	1.53	1.76	0.99	1.80
1.52	1.49	1.60	1.49	
Average dft of all Spot Measurement Averages (prior to cleaning)				1.59 mils*

Note: The average dft after cleaning will be less than 1.59 mils, since this figure includes chalk still remaining on the surface. The exact contribution of the chalk to the dft figures presented in Table 11is unknown but it is reasonable to conclude that it represents approximately 0.25 to 0.50 mils of the measured dft.

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Flight Control Tower - Dry Film Thickness Measurement (Final Inspection)					
Structure & Location	Final Inspection Ft. Campbell Batch 21 10/24/2005 Flight Control Tower				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	7.2	7.2	6.8	4.9	5.9
Gage Reading #2	8.8	8.2	8.2	4.0	8.4
Gage Reading #3	8.4	8.4	12.3	6.4	6.7
Average DFT	8.1	7.9	9.1	5.1	7.0
Average of All Five Spot Measurements					7.5

Structure & Location	Final Inspection Ft. Campbell Batch 22 10/24/2005 Flight Control Tower				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	6.7	10.1	7.5	9.8	9.2
Gage Reading #2	9.5	6.8	8.4	8.3	5.0
Gage Reading #3	6.5	13.9	10.5	10.4	5.0
Average DFT	7.6	10.3	8.8	9.5	6.4
Average of All Five Spot Measurements					8.5

Structure & Location	Final Inspection Ft. Campbell Batch 23 10/24/2005 Flight Control Tower				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	6.1	7.5	8.1	7.2	5.9
Gage Reading #2	7.0	5.0	6.7	6.7	5.6
Gage Reading #3	7.9	5.9	8.2	6.0	5.5
Average DFT	7.0	6.1	7.7	6.6	5.7
Average of All Five Spot Measurements					6.6

Structure & Location	Final Inspection Ft. Campbell Batch 24 10/24/2005 Flight Control Tower				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	7.9	5.5	5.3	7.2	6.2
Gage Reading #2	6.0	7.1	8.7	4.9	5.8
Gage Reading #3	5.9	5.6	9.0	4.4	7.1
Average DFT	6.6	6.1	7.7	5.5	6.4
Average of All Five Spot Measurements					6.4

Structure & Location	Final Inspection Ft. Campbell Batch 25 10/24/2005 Flight Control Tower				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	6.2	5.0	7.4	4.6	7.0
Gage Reading #2	6.2	4.8	5.6	5.8	7.9
Gage Reading #3	6.5	5.8	7.8	7.4	6.3
Average DFT	6.3	5.2	6.9	5.9	7.1
Average of All Five Spot Measurements					6.3

Structure & Location	Final Inspection Ft. Campbell Batch 26 10/24/2005 Flight Control Tower				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	8.9	4.7	4.7	4.4	6.1
Gage Reading #2	6.8	5.0	4.6	6.2	7.5
Gage Reading #3	4.7	5.5	4.6	6.3	10.1
Average DFT	6.8	5.1	4.6	5.6	7.9
Average of All Five Spot Measurements					6.0

Structure & Location	Final Inspection Ft. Campbell Batch 27 10/24/2005 Flight Control Tower				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	11.2	5.4	5.2	4.2	8.6
Gage Reading #2	7.6	4.0	4.3	10.3	8.7
Gage Reading #3	3.7	7.0	5.6	8.1	10.6
Average DFT	7.5	5.5	5.0	7.5	9.3
Average of All Five Spot Measurements					7.0

Structure & Location	Final Inspection Ft. Campbell Batch 28 10/24/2005 Flight Control Tower				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	9.4	5.9	11.2	6.0	9.8
Gage Reading #2	10.2	4.8	9.2	5.5	6.8
Gage Reading #3	8.8	7.5	8.9	10.4	8.1
Average DFT	9.5	6.1	9.8	7.3	8.2
Average of All Five Spot Measurements					8.2

Structure & Location	Final Inspection Ft. Campbell Batch 29 10/24/2005 Flight Control Tower				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	7.8	5.3	4.1	5.6	7.1
Gage Reading #2	9.5	6.3	3.7	6.6	7.3
Gage Reading #3	6.8	7.8	4.5	6.0	8.1
Average DFT	8.0	6.5	4.1	6.1	7.5
Average of All Five Spot Measurements					6.4

Structure & Location	Final Inspection Ft. Campbell Batch 30 10/24/2005 Flight Control Tower				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	7.9	3.2	5.8	4.9	7.7
Gage Reading #2	6.2	5.5	3.5	6.1	9.0
Gage Reading #3	5.2	3.7	4.3	6.0	6.2
Average DFT	6.4	4.1	4.5	5.7	7.6
Average of All Five Spot Measurements					5.7

Structure & Location	Final Inspection Ft. Campbell Batch 31 10/24/2005 Flight Control Tower				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	3.4	4.2	3.4	5.8	4.5
Gage Reading #2	3.8	6.4	3.1	4.6	3.9
Gage Reading #3	4.8	4.0	4.9	5.2	5.7
Average DFT	4.0	4.9	3.8	5.2	4.7
Average of All Five Spot Measurements					4.5

Structure & Location	Final Inspection Ft. Campbell Batch 32 10/24/2005 Flight Control Tower				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	5.4	4.4	3.9	5.7	4.0
Gage Reading #2	6.3	5.0	3.8	5.0	4.7
Gage Reading #3	8.0	4.1	5.0	5.3	6.0
Average DFT	6.6	4.5	4.2	5.3	4.9
Average of All Five Spot Measurements					5.1

Structure & Location	Final Inspection Ft. Campbell Batch 33 10/24/2005 Flight Control Tower				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	9.0	3.0	3.7	4.0	6.7
Gage Reading #2	8.4	4.2	4.6	3.9	4.2
Gage Reading #3	7.3	4.1	3.7	5.3	4.3
Average DFT	8.2	3.8	4.0	4.4	5.1
Average of All Five Spot Measurements					5.1

Structure & Location	Final Inspection Ft. Campbell Batch 34 10/24/2005 Flight Control Tower				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	5.0	6.4	5.3	4.6	5.7
Gage Reading #2	4.7	4.6	4.7	4.4	5.9
Gage Reading #3	5.5	5.4	4.1	5.5	4.5
Average DFT	5.1	5.5	4.7	4.8	5.4
Average of All Five Spot Measurements					5.1

Structure & Location	Final Inspection Ft. Campbell Batch 35 10/24/2005 Flight Control Tower				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	5.3	7.2	5.0	7.0	4.4
Gage Reading #2	5.0	4.0	4.1	6.7	5.0
Gage Reading #3	5.8	6.8	5.9	3.8	3.7
Average DFT	5.4	6.0	5.0	5.8	4.4
Average of All Five Spot Measurements					5.3

Structure & Location	Final Inspection Ft. Campbell Batch 36 10/24/2005 Flight Control Tower				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	11.5	10.5	5.8	4.6	7.8
Gage Reading #2	8.6	8.3	6.6	5.1	5.5
Gage Reading #3	8.4	5.8	5.4	4.2	6.3
Average DFT	9.5	8.2	5.9	4.6	6.5
Average of All Five Spot Measurements					7.0

Structure & Location	Final Inspection Ft. Campbell Batch 37 10/24/2005 Flight Control Tower				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	5.4	5.8	6.0	5.8	5.0
Gage Reading #2	5.2	6.4	5.3	8.9	5.0
Gage Reading #3	5.3	5.4	4.4	7.0	5.0
Average DFT	5.3	5.9	5.2	7.2	5.0
Average of All Five Spot Measurements					5.7

Structure & Location	Final Inspection Ft. Campbell Batch 38 10/24/2005 Flight Control Tower				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	6.5	6.0	4.9	4.2	4.9
Gage Reading #2	5.9	6.7	7.7	5.2	5.7
Gage Reading #3	7.3	4.2	5.2	5.1	3.7
Average DFT	6.6	5.6	5.9	4.8	4.8
Average of All Five Spot Measurements					5.5

Structure & Location	Final Inspection Ft. Campbell Batch 39 10/24/2005 Flight Control Tower				
	Spot Measurement #1	Spot Measurement #2	Spot Measurement #3	Spot Measurement #4	Spot Measurement #5
Gage Reading #1	7.1	5.6	4.7	5.9	5.6
Gage Reading #2	6.1	4.9	4.1	5.5	4.2
Gage Reading #3	5.1	6.3	4.8	7.0	4.5
Average DFT	6.1	5.6	4.5	6.1	4.8
Average of All Five Spot Measurements					5.4

SUMMARY REMARKS

This Final Inspection Report represents the condition of the structures on October 24 – 26, 2005, at the time the inspection was conducted by MARK 10 Resource Group, Inc. Specific areas identified during the inspection that required additional work in order to comply with the MANTA's scope of work were discussed with MANTA's on site supervisor and corrected during the final inspection. Issues observed during the in-progress inspection that was conducted in September 2005 were rechecked during the final inspection.

Many of the issues observed during the final inspection were minor and required minimal corrective action. Some issues, such as the high dry film thickness on Hangar #2 could not be remedied during the final inspection. Overall it appears that MANTA did an excellent job, given the conditions.

Since this project involved overcoating previously applied coatings, it is possible that problems may develop in the future once the coatings experience several thermal cycles but at the time of the final inspection the coatings looked very good.

Respectfully Submitted,

Mike O'Brien
President – MARK 10 Resource Group, Inc.
NACE Certified Coating Inspector # 2484

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14. ABSTRACT

The objective of this research was to demonstrate and implement cost-effective paint maintenance procedures for steel structures, including overcoating existing coatings with surface tolerant, self-healing, and extremely durable coatings. Maintenance painting of this type does not require extensive surface preparation, and can be significantly less expensive than other maintenance practices, particularly when the existing coating contains lead or other hazardous materials. Candidate steel and galvanized steel structures requiring maintenance painting at Fort Campbell were assessed to determine the suitability of various paint maintenance procedures, prior to overcoating. Air dry fluoropolymer coatings, implemented for the flight control tower, have emerged as a premium re-coat product for factory installed polyvinylidene fluoride coatings as well as for use in coating other weathered coatings. Moisture cured polyurethanes, which are tolerant of relatively poor application conditions and generally can be applied at very high humidity and low temperatures, were successfully implemented as overcoatings for deluge tanks and aircraft hangars. Self-healing smart coatings, which incorporate microcapsules mixed into paint as a dry powder at the time of application, were also implemented for critical areas of deluge tanks.

15. SUBJECT TERMS

Fort Campbell, KY; paint maintenance; steel structures; moisture-cured polyurethanes (MCU); hangars; control towers; deluge tanks

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